Sky and TELESCOPE

Haggart Observatory

In This Issue:

Vol. XI, No. 11

SEPTEMBER, 1952

Whole Number 131

SOUTH AFRICAN TERCENTENARY

It is 300 years since the first white men settled in South Africa under Jan van Riebeeck. This event was celebrated by a large fair at Cape Town in March and April of this year. There was a hall of science in which astronomy, "the senior science in South Africa" according to a 68-page descriptive pamphlet, occupied a prominent position. Dr. David S. Evans, of the Royal Observatory at Cape Town, has sent us photographs and a brief description of the astronomical exhibits.

In 1652, van Riebeeck himself discovered a comet. A few other comets were found and some astronomical observations were carried out between then and 1751, when the work of the Abbé de Lacaille — who catalogued 10,000 stars within two years, determined the longitude of the Cape, and got a fairly accurate distance for the sun — made the Cape famous in this field.

Now astronomical South Africa is truly international. There are eight astronomical institutions in the country, including the Trigonometrical Survey Office. English, Dutch, and American observatories (and at Harvard's station the Irish are also represented) had displays in the hall of science exhibit showing something of their work. In several instances models of larger instruments were also shown, as well as historic documents and old instruments.

ASTRONOMISCHE GESELLSCHAFT

The reports of the German astronomical society, the Astronomische Gesellschaft, for the year 1951 have just been received. There are reports of 18 observatories and abstracts of 27 papers. For the first time in its history this society held its annual meeting, not in a professional observatory or university but in an industrial center in the Ruhr valley, at a public observatory in Recklinghausen which had encouraged the growth of a large local amateur group.

Of general interest is the news that the extensive bibliography of variable stars begun by the late Richard Prager is being completed. When he was forced to leave Berlin under Hitler, Dr. Prager was not allowed to take the practically completed manuscript of the third volume with him, and in 1945 it was lost. This work, for Orion-Vulpecula for references through 1930, has been done over and should be distributed this year. Supplementary volumes bringing the bibliography for all named variables up to 1950 are expected to be completed by 1954.

D. H.

Sky and TELESCOPE

In Focus

SHORTLY after Halley's comet faded from telescopic view in June, 1911, a new comet, destined to be but slightly inferior to its famous predecessor, was sighted. It was discovered by Prof. William R. Brooks, of Smith Observatory, Geneva, N. Y., and for the discovery he received his 10th gold comet medal from the Astronomical Society of the Pacific.

Found on July 20, 1911, at about 11th magnitude, the comet slowly brightened until by August 17th it was visible to the naked eye. On October 20th, a Harvard Observatory bulletin announced an increase in brightness, as well as a 20-degree tail. The comet was then a 2nd-magnitude object, visible in the eastern morning sky.

Three days later, E. E. Barnard, at Yerkes Observatory, made the photograph reproduced on our back cover. Using the 10-inch Bruce telescope, he exposed the Lumière Sigma plate for an hour and 15 minutes. The plate was guided on the comet, and refraction by the atmosphere caused the peculiar curves of the star trails.

Barnard wrote in the **Astrophysical Journal** in 1912:

"Up to the middle of October the comet was a great disappointment from a photographic standpoint, for, though bright and conspicuous to the naked eye, its effect upon the sensitive plate was very slow, and long exposures were required to show the tail, which was simply a straight and rather narrow stream of diffused matter, with nothing of interest except occasionally an effort at additional streamers near the head. The photographs were very much alike night after night and it looked as if the comet would not be of any special importance. This condition continued until near perihelion, when it suddenly became an object of the deepest interest and showed a wealth of detail in the structure of the tail that has been equaled by only one comet (Morehouse's) since photography has recorded their spectacular changes."

The comet passed closest to the sun on October 27, 1911, moving into the evening sky. Observers at Mount Wilson could still see the comet faintly with the naked eye on November 24th, and southern observers followed it into the next year with telescopic aid.

Several of Brooks' comets hold their peculiar claims to fame, including the periodic Comet Brooks II, which passed between Jupiter and its satellites in 1886 and as recently as 1946 still returned.

VOL. XI, NO. 11
WHOLE NUMBER 131
SEPTEMBER, 1952

CONTENTS

COVER: The observatory of Harold P. Haggart at Oregon City, Ore., houses a 20-inch telescope. The instrument, mounting, and dome were all designed and built by Mr. Haggart. Photograph by Bob Barnes. (See page 282.)

BACK COVER: Comet Brooks, photographed on October 23, 1911, by E. E. Barnard, at Yerkes Observatory. On a small-scale plate exposed simultaneously, the comet exhibited a 17-degree tail, but only 11 degrees show to the edge of the back-cover plate. (See In Focus.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions, and to Latin-American countries; $7.00 for two years. Add $1.00 per year for Canada and for all other foreign countries, making the total subscription $5.00 per year and $9.00 for two years. Canadian and foreign remittances should be made in United States currency. Single copies, 35 cents, foreign 45 cents. Circulation staff: Betty G. Dodd, manager; Nancy R. Bolton; Virginia K. McAuliffe.

All notices of change of address must be sent three weeks in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts.

"Give Us Back Our Fortnight!"

By Ralph S. Bates, *State Teachers College, Bridgewater, Mass.*

"GIVE us back our fortnight," was the cry. There were riots in various parts of England, especially at Bristol where several persons were killed. The occasion was the introduction of the Gregorian calendar into England, and the year was 1752. The innovation was bitterly opposed by many, and misunderstanding and confusion resulted, although the Act of Parliament had been carefully framed to prevent injustice in the matter of collection of payments and interest. Still, when, by order of Parliament, the day following September 2, 1752, became September 14, 1752, many men felt they had been robbed of 11 days. Some believed they would die that much earlier. Like many another important scientific innovation, the introduction of the Gregorian calendar encountered ignorance and opposition.

In order to understand the wherefores of the Gregorian reform, it is necessary to delve a bit into the history of the calendar. The Egyptians, and other early peoples, used a year of 12 months of 30 days each, and later added five days to the end of the year to make a year of 365 days. The Greeks and Romans experimented with various calendars, and much confusion resulted. By the time of Cicero and Caesar, for example, the Romans found the vernal equinox occurring around the Ides of May according to their reckoning. In order to correct the dislocation of this and the Roman festivals, Caesar decided to reform the calendar, and was aided by Sosigenes, an Alexandrian astronomer. The cardinal feature of the new Julian calendar was the adoption of a solar year of 365 days, 6 hours. This was in close accord with the best astronomical knowledge of the times, for Hipparchus, according to Mommsen, had determined the tropical year (the interval between two successive returns of the sun to an equinox) as 365 days, 5 hours, 52 minutes, and 12 seconds. Caesar's second step was to decree that the normal length of the year should be 365 days, with an additional day intercalated every fourth year after February 24th to complete the 365¼ days (approximately) in the tropical or solar year. Such a year of 366 days is called a bissextile or leap year. This new system was put into operation in 45 B.C.

In A.D. 325 the Council of Nicaea decreed that the celebration of Easter should be uniform throughout Christendom. Easter tables were apparently drawn up on the assumption of the vernal equinox falling on the 21st of March in the year of the Council. As time wore on, the actual excess of 11 minutes in the length of the Julian year caused the calendar date of the vernal equinox to fall constantly earlier. The annual error accumulated to a day in 128 years. By the 16th century, the vernal equinox had receded to March 11th, and the Council of Trent authorized the Pope to take up the matter. Ultimately, Gregory XIII, accepting the calendar reforms proposed by a Neopolitan physician, Lilius Aloysius (Luigi Lilio Ghiraldi), issued a bull dated February 24, 1582.

The principal provisions of the bull that affect our subject were: 1. In order to restore the vernal equinox to March 21st (the day adopted by the Nicaean fathers as the date of its assumed occurrence in A.D. 325), 10 days were to be omitted from the calendar of 1582; the day following October 4th was declared to be October 15th. 2. In order to provide a more exact correspondence between the calendar year and the tropical year, it was provided that three out of every four century years should be common years, instead of leap years as they were according to the Julian calendar. The century years divisible by 400 without a remainder were left as leap years; thus 1600 was a leap year; 1700, 1800, and 1900 were not, and 2000 will be.

All this was an improvement on the Julian calendar. Since, however, the length of the mean Gregorian year is $365^d\ 5^h\ 49^m\ 12^s$, while that of the tropical year is, according to modern determination, $365^d\ 5^h\ 48^m\ 46^s$, the Gregorian year is still 26 seconds too long, an error that will not amount to an entire day for more than 3,000 years. Clavius, who published his *Romani Calendarii a Gregorio XIII, Restituti Explicatio* at Rome in 1603, and other scholars applied the calendar to a new ordering of the Christian festivals.

The Gregorian calendar went into effect about 1582 in various Catholic parts of Europe, such as France, Spain, and some Italian states. The Greek church would not adopt the new calendar. Most Protestant countries, refusing to recognize the Pope's authority, likewise did not adopt it. As time wore on, however, and the advantages of the new calendar became apparent, as well as the advantages of having the same calendar as one's neighbors, they too came to adopt the Gregorian calendar, England and the American colonies accepting it in 1752.

England had long adhered to the Old Style calendar, "as if it were matter of heresy to receive a Calendar amended by a Pope," as Walpole put it. England was, moreover, using not only the "historical year," which began on January 1st, but civil, ecclesiastical, and legal years, which began on March 25th,

"Humours of an Election Entertainment" are portrayed in this engraving by Hogarth. The work, dated February 24, 1755, was one of a series of four plates satirizing politics of the times. The banner on the floor proclaims, "Give us Our Eleven Days," referring to the calendar reform made in 1752.

making it necessary to write a date as 14 February, 1744/5, as may be seen from correspondence between the Duke of Newcastle and Lord Chesterfield. To add to the confusion, Scotland had been beginning the year on January 1st ever since 1600. Various Englishmen had been agitating calendar reform for a long time. John Dee had written "A Playne Discourse... Concerning the Needful Reformation of the... Kalender."

Matters were finally brought to fruition by Lord Chesterfield after an uphill fight. When he first broached the subject of calendar reform to the Duke of Newcastle he found him "alarmed at so bold an undertaking... and [he] conjured me not to stir matters that had long been quiet; adding that he did not love new-fangled things." (W. H. Craig, *Life of Lord Chesterfield,* London, 1897, 305.) The prime minister, Henry Pelham, and others being more favorable, Chesterfield "cooked up a Bill," as he says, and got the backing of Martin Folkes, president of the Royal Society, and James Bradley, the Astronomer Royal. Chesterfield sought to prepare the public mind for the change by distributing essays on the subject to various periodicals.

The bill was drawn up by a barrister named Peter Davall, at the time secretary of the Royal Society, and was introduced by Chesterfield on February 25, 1751. It passed to a second reading on March 18th, and was strongly advocated in speeches by Lords Chesterfield and Macclesfield, who dwelt on the inconvenience of being 11 days out of step with the rest of Europe. It was amended by the House of Commons, returned to the House of Lords, and received royal assent on May 22, 1751. The "Act for regulating the commencement of the year and for correcting the calendar now in use" provided that the year should henceforth begin for all purposes on January 1st, and that the 11 intermediate days between September 2 and 14, 1752, should be omitted, so that the day following the 2nd would be reckoned the 14th. The first provision proved popular. The dropping of the 11 days from the calendar was unpopular in some quarters and led to temporary confusion. The calendar thus reformed became known as New Style (N.S.) as contrasted to the older Julian or Old Style (O.S.)

Typical of the ignorance and confusion of the period is this from Felix Farley's *Journal* of January 6, 1753 (as reported in John Latimer, *Annals of Bristol,* 1893, 298).

"Yesterday being Old Christmas Day, the same was obstinately observed by our country people in general, so that (being market day according to the order of our magistrates) there were but few at market, who embraced the opportunity of raising their butter to 9d. or 10d. per pound [about twice the ordinary price]. ..."

Philip Stanhope, Earl of Chesterfield (1694-1773), famous essayist noted for his letters to his son, was a key figure in the English calendar reform. From a picture by O. Humphry.

The *Annals* go on to say, "In some market towns the farmers were wholly absent; and to gratify the feelings of their parishioners, many rural clergymen preached 'Nativity sermons' on the following Sunday. The flowering of the celebrated Glastonbury thorn was looked for with much anxiety. The first intelligence of its deportment gave satisfaction, the above newspaper affirming that the holy plant after having contemptuously ignored the new style, burst into blossom on the 5th of January, thus indicating that Old Christmas Day should alone be observed, in spite of an irreligious legislature.... Eventually some one thought it worth while to write to the vicar of Glastonbury, and the emptiness of the report was at once made known, the reverend gentleman declaring that the thorn 'blossomed the fullest and finest about Christmas Day, new style, or rather sooner.' "

When Lord Macclesfield's eldest son stood for election for Oxfordshire in 1754, the mob raised against him the vehement cry of "Give us back the eleven days we have been robbed of." Shortly thereafter, the moralistic artist of the times, Hogarth, got out a series of engraved illustrations entitled, "Four Prints of an Election," the one reproduced here indicating how the calendar reform was an election issue.

Bradley, best remembered by posterity for his somewhat earlier discovery of the aberration of light, was consulted in regard to the Gregorian calendar, and prepared tables for the new calendar and religious reckonings. When, a few years later, he was stricken by the painful illness which culminated in his death, "many of the common people attributed his sufferings to a judgment from heaven for his having been instrumental in what they considered to be so impious an undertaking."

England was by no means the most belated of the countries to adopt the Gregorian calendar. It was recognized by Japan in 1873, by China when she became a republic in 1911, by Turkey in 1917, and by Russia in 1918. When Alaska was annexed to the United States from Russia in 1867, the official dates had to be changed. By then, the calendar difference was 12 days. A change of only 11 days was necessary, however, one day being provided for by the transfer of Alaska from Asiatic to American dates (crossing the international date line).

Dates in Russia were sometimes written for scientific purposes in both reckonings, for instance, July 9/22; by then the calendars had become 13 days apart, since 1800 and 1900 were leap years in the Julian calendar but not in the Gregorian. The Russian calendar later improved the Gregorian leap year rule.

On September 14, 1952 (N.S.), people throughout the British Empire and in the United States will be celebrating the 200th anniversary of the inauguration by their ancestors of the Gregorian calendar.

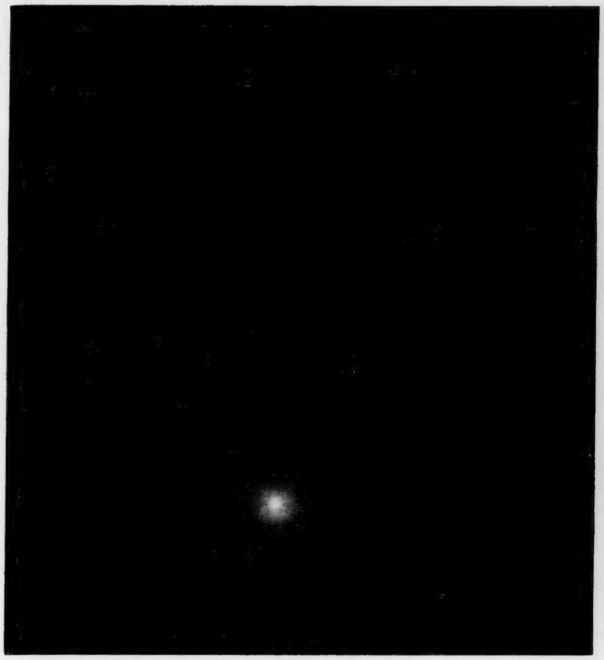
THE DAILY ADVERTISER, a contemporary four-page paper published in London, is carefully datelined THURSDAY, September 14, 1752, N.S. On its first page is an advertisement for an almanac (and a navigation course by its author), which begins:

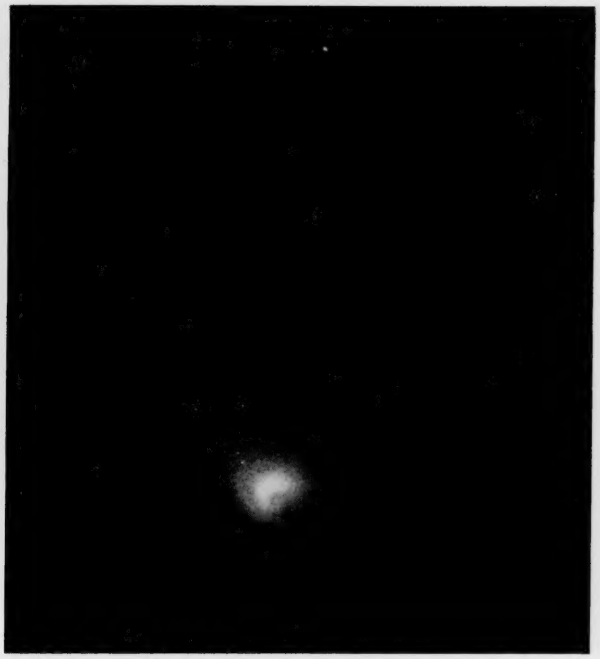
"This Day are publish'd, (Price ls. 6d.) According to Act of Parliament, THE GREGORIAN and JULIAN KALENDARS: Wherein are taught, besides the Julian Account of Time, how to find, arithmetically, the Leap-Year, Golden Number, Epact, Dominical Letter, Easter-Day, the Moon's Age,..."

A poem, the name of whose author is undecipherable on the microfilm copy of the paper, was also a front-page item:

JUMPED O

What a whimsical Change will be wrought in our Life,
By this odd-fangled Leap-Frog, of old and new "Style."
TIME hastens his Pace, in his boundless Career,
To add to the Jokes of this marvellous Year;
When, from Britons, *eleven broad Days took their Flight,*
And, waking, all swore they had slept but one Night.





The head of Halley's comet contained a small, bright nucleus surrounded by several diffuse asymmetric envelopes of ejected material. The coma appeared most dense on the side facing the sun. These are exposures of four and eight minutes, made on May 5 (left) and May 8, 1910, respectively, with the Mount Wilson 60-inch reflector.

COMET THEORIES

BY OTTO STRUVE, *Leuschner Observatory University of California*

AT THE AGE of 12, Friedrich Wilhelm Bessel took a round piece of window glass and ground it with sand, in a small platter, until it became a crude lens and could focus the rays of the sun. Apparently this small incident started him on his astronomical career. He soon began to show great inclination toward arithmetical calculations, and his father therefore decided to send him as an apprentice into the mercantile establishment of A. G. Kulenkamp in Bremen. Presumably his mathematical skill was to be given free rein in keeping the accounts of their sales and purchases!

But in Bremen there was living at that time the great astronomer H. W. M. Olbers (1758-1840), whose work on comet orbits was already known all over the world. Bessel attended some public lectures by Olbers, and soon became so interested in this subject that he purchased a copy of Lalande's textbook of astronomy. With its help he started to compute the orbit of Halley's comet of 1607 from observations by Harriot that had been uncovered in some family archives in England and published a few years earlier.

On July 28, 1804 (when Bessel had just celebrated his 20th birthday), he accidentally saw Olbers on a Bremen street. Although he had not been personally acquainted with him, Bessel quickly overtook him and met him face to face: Would Olbers permit him to bring to his house a short manuscript on the comet of 1607? Olbers would! And half an hour later the first product of Bessel's scientific labors was in Olbers' hands. Many years later Bessel described what happened next:

"The next day, a Sunday, was free from work in the office during the afternoon; excitement over Olbers' reaction to my paper induced me to take a long walk. When I returned home I found a letter from Olbers, and some books. . . ." The famous man had "read with the greatest pleasure your excellent discussion. . . . It showed remarkable mathematical and astronomical knowledge, as well as excellent skill in the most difficult parts of calculus." The paper was submitted by Olbers for publication in the *Monatliche Correspondenz* of von Zach, and was printed in Volume X for 1804. Thus Bessel, who is now best known for his parallax determination of 61 Cygni, really began his work as a computer of comet orbits, and throughout his life this first astronomical topic again and again occupied his brilliant mind.

In 1836 Bessel published three important papers on comets in the *Astronomische Nachrichten.* The first contained his own observations of the physical characteristics of Comet Halley in 1835. He discovered "an emanation from the comet, approximately in the direction of the sun, which had the appearance of a burning rocket and which must have had the same effect upon the motion of the comet as the burning of the inflammable material has upon the motion of a rocket: it produces a velocity in the direction opposite to that of the escaping jet."

The second article was on the orbit of Biela's comet, and the third was entitled, "On the Possible Inadequacy of the Theory of Comets Based Solely upon the Law of Gravitation." This latter paper is the forerunner of F. L. Whipple's new and exciting ideas. In it Bessel points out that jets, like the one he had seen in Halley's comet, are quite common and that "their influence upon the motion of a comet is a necessary consequence; not the existence of this effect but only its amount is unknown."

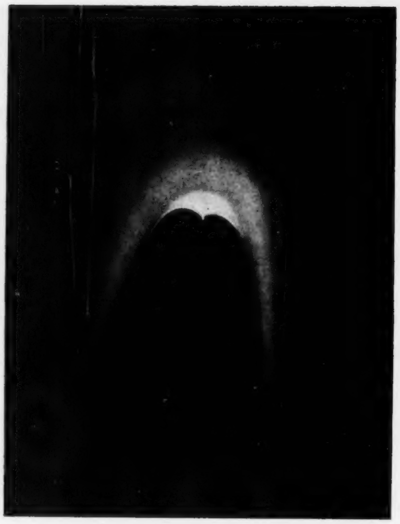
Then he proceeds to determine what would be the acceleration, or the shortening of the period, of Comet Halley if the jet in the direction of the sun lasted between October 2 and 25, 1835, and amounted to a loss of mass equal to 1/1,000 of the total mass of the comet per day. The result is a shortening of the 77-year period by 1,107 days! Bessel thought that his estimate of the mass of the jet was conservative, because the brilliance of the streamer often equaled that of the nucleus itself. But we

know now that these gaseous ejections contain much less mass than the solid nucleus of the comet, for the latter only reflects sunlight and is therefore of low brightness compared to the material that is ejected, which absorbs and re-emits solar energy as well as reflecting it.

There arose in Germany a controversy between Encke and his followers on one side and Bessel on the other. Encke had tried to explain the shortening of the period of the comet known by his name as the result of a resisting medium in the solar system. Though recognizing the possibility that Encke's theory might be correct, Bessel cautioned against blind faith in the simple dynamical theories evolved from the law of gravitation. If, for example, there should be found cases in which the periods of comets are lengthening with time, rather than shortening, then the theory of a resisting medium would have to be abandoned. Moreover, the motions of the planets and the moon showed no such effect.

It occurred to Whipple that comets are actually seen to evaporate some of their gaseous constituents into space. Somehow the particles escape from the illuminated and heated side of the comet nucleus and produce in the comet's head a symmetrical sharply bounded halo, or a coma which is also symmetrical but has no definite outline, or finally a series of envelopes — parabolically shaped hoods surrounding the nucleus.

All these formations consist mostly of gaseous atoms and molecules with some admixture of free atoms. The most common substances are simple molecules (radicals) consisting of two light atoms, such as hydroxyl (OH) or NH, CH, CN, C_2. Most of these molecules are not very stable, and they are readily decomposed by the action of sunlight; in turn it is the pressure of sunlight that drives the decomposition products,

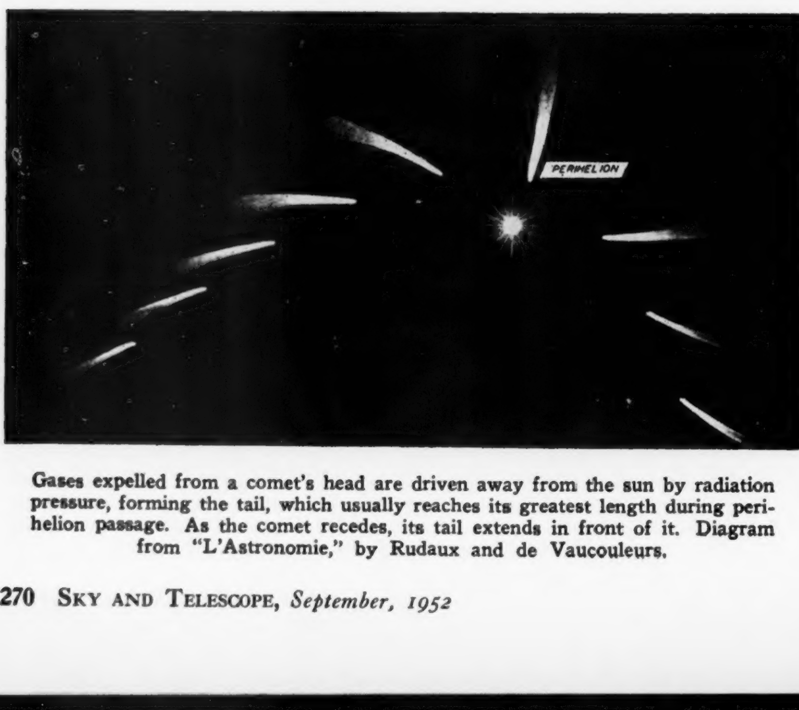


A drawing of the head of the Great Comet of 1861, by Warren de la Rue, with a 13-inch refractor. Note the parabolic envelopes and the great brightness on the sunward side.

N_2, CO, CO_2, and the like, into the tail of the comet.

But where do the unstable radicals in the coma come from? It is not probable that they could have existed as radicals in the nucleus for a considerable length of time, because they do not ordinarily last longer than a very short time before they produce chemical reactions among themselves or with other molecules and atoms. Largely through the work of K. Wurm, P. Swings, and N. T. Bobrovnikoff,* we know that the comet's nucleus contains not the actually observed radicals OH, NH, and so on, but a group of fairly ordinary

*Dr. Bobrovnikoff's article on comets in the new McGraw-Hill volume, *Astrophysics*, is an excellent summary of cometary physics and chemistry.



Gases expelled from a comet's head are driven away from the sun by radiation pressure, forming the tail, which usually reaches its greatest length during perihelion passage. As the comet recedes, its tail extends in front of it. Diagram from "L'Astronomie," by Rudaux and de Vaucouleurs.

parent molecules, among which water (H_2O), ammonia (NH_3), methane (CH_4), and a few other substances have been suggested. These are not directly observed, but their existence is inferred in the manner indicated above.

On the earth some of these substances are gaseous (ammonia) or liquid (water), or both. But Swings and Wurm (who cites an earlier statement by the German physicist Harteck) have long ago pointed out that at the average distances of most comets from the sun, which may be of the order of 100,000 astronomical units, all these parent molecules will form solids: ordinary ice or snow in the case of water, and ices of ammonia, methane, and the like for other substances.

Quite recently Swings and A. H. Delsemme, in Belgium, re-examined this problem. When the comet is very far from the sun and is very cold, the feeble solar rays falling upon the frozen mass cause no evaporation (or sublimation); their energy is all used up to cause the molecules to vibrate and to rotate. It is only when the comet approaches the sun and the heating effect of sunlight has surpassed a certain critical value that evaporation begins through the gradual loosening of the molecules from the ice. In the case of a comet, the evaporated molecules escape into what is for most practical purposes a perfect vacuum. But the amount of evaporation per second depends upon the molecular bonds or forces of cohesion within the ice; these differ from one substance to another.

Laboratory physicists have found it more convenient to determine, in place of the actual forces of cohesion, a quantity known as the ***saturation vapor pressure.*** If evaporation or sublimation occurs from a solid into an empty closed vessel, then after a while a state of equilibrium will set in; the number of molecules leaving the solid will be equal to the number which recondense upon the solid. This occurs at a certain pressure of the gas — different for different temperatures — which is the saturation pressure of the vapor. If the cohesion is weak, a large saturation pressure is built up before equilibrium is reached, and vice versa.

The Belgian astrophysicists examined the saturation pressures of the vapors of methane (1,000 millimeters of mercury at $-160°$ centigrade), ammonia (0.0001 millimeter), and water (10^{-11} millimeter). These values are so different that for a comet of a certain temperature, according to its distance from the sun, we would expect that methane with its small cohesion would very quickly evaporate, while water ice would produce hardly any vapor. We would then be unable, however, to explain why comets always show simultaneously the spectra of OH and CH, the one

resulting from the decomposition of water and the other of methane.

It is therefore of great interest to learn that the various parent molecules can combine with molecules of water to form solid substances, called hydrates. For example, carbon dioxide may become associated with six water molecules, forming the solid hydrate $CO_2 . 6H_2O$. These hydrates all have approximately the same saturation vapor pressures, intermediate between those of pure methane and pure water. Swings and Delsemme therefore suggest that the solids in comets contain not only the pure ices of H_2O, NH_3, CH_4, and so on, but also their hydrates. The evaporation of all the latter would be similar, and once molecules of the hydrates became detached from the solid they would quickly be decomposed to produce the observed radicals, and later the tail spectra.

Whipple pictures a comet as a mixture of these ices, with grains of meteoric material embedded in them, consisting of mostly iron, calcium, manganese, magnesium, chromium, silicon, nickel, aluminum, and sodium. There is no indication as to the sizes of these grains. Probably they range all the way from free atoms — which produce metallic emission lines in cometary spectra at solar distances where the metal should be so cold as to be almost impervious to evaporation from its own solid — to large blocks of some centimeters or even meters in size.

The comet is thought of as a solid body; Whipple describes it as a "dirty iceberg" or as "rotten ice." As this mass approaches the sun, the lighter parent molecules evaporate. This causes a rebound, which would be directed radially away from the sun in a nonrotating comet, but which possesses either a forward component of force in a comet that rotates in the retrograde sense (opposite to its orbital motion), or a retarding component when the rotation is direct. This asymmetry is caused by the lag required to heat through a sufficiently thick layer of the ice to get the evaporation going.

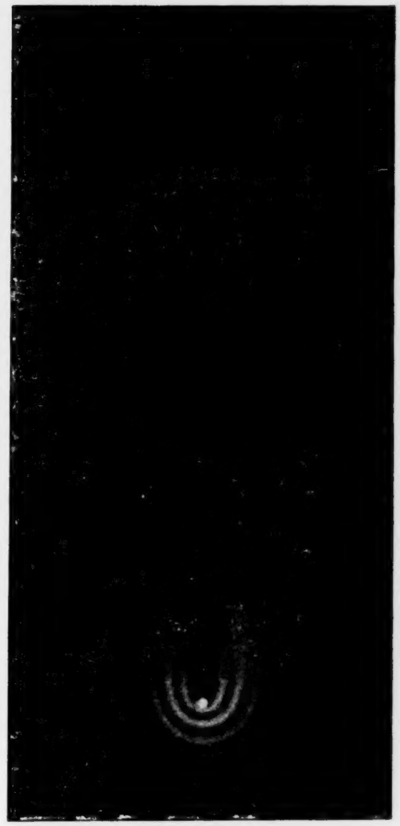
We recognize in this mechanism the idea of Bessel, and when Whipple applied it to Comet Encke (*Sky and Telescope,* October, 1949, page 308), it explained in a most convincing manner the tendency of this comet to spiral slowly inward toward the sun. The hypothesis became virtually a certainty when Whipple next applied it to Comet d'Arrest, for which the computations of A. W. Recht had consistently given a lengthening of period. Astronomers call this deceleration, even though the phenomenon begins with a forward push by the unsymmetrical rebound of the evaporating molecules — the comet spirals outward, its orbit increases in size and its mean motion becomes slower.

Several other comets, some computed by Whipple, others by A. Dubiago, in Russia, have given equally satisfactory results.

If the rotation period of each comet were known, and if it were possible to compute the time lag of the heat transfer, the problem could be completely solved. Whipple knew that as the ices melt upon successive returns of a periodic comet its surface must become increasingly "dirty," until it resembles a glacial moraine under which a layer of solid ice is well protected from sunlight. From the observed accelerations and decelerations, and making the best assumptions possible, Whipple computed that on the average a comet evaporated 1/200 of its mass in a single perihelion passage. This means that there would be enough mass in such a comet as Encke's to last about 200 returns, or 660 years.

This result accords well with Bobrovnikoff's estimates of the lifetimes of comets. But Whipple remarks that the division and ultimate disappearance of Comet Biela, which by his computation might have lived to be 6,000 years old, definitely prove that other processes — perhaps in the nature of a catastrophic collapse of a shell of "rotten ice" — might result in a more rapid disintegration.

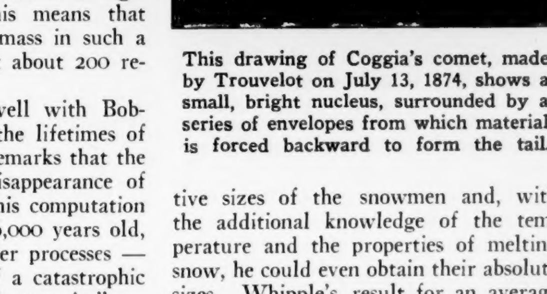
Whipple could next infer the size of a comet's solid-ice nucleus. The problem is similar to that of a boy whose friend has made two snowmen, one large, the other small, and placed them on a warm day in an inaccessible place. All the boy sees is a stream of melting water from the large mass of snow, and a small trickle from the other. A comparison of the two amounts of water would enable him to compute the relative sizes of the snowmen and, with the additional knowledge of the temperature and the properties of melting snow, he could even obtain their absolute sizes. Whipple's result for an average comet nucleus is a sphere of radius one kilometer, containing about 4×10^{15} grams of matter.



This drawing of Coggia's comet, made by Trouvelot on July 13, 1874, shows a small, bright nucleus, surrounded by a series of envelopes from which material is forced backward to form the tail.

As the ices melt and evaporate, they must carry off with them some of the surface blocks of meteoric material. Whipple attributes to this process the spread of the particles in meteor showers associated with known comets. This part of his discussion is the most intriguing of all, and it deserves special treatment in a later article. Here it

(Continued on page 273)



A composite diagram of the Whipple effect for three cases: a. The comet nucleus is not rotating; symmetrical evaporation on the warm side produces rebound away from the sun; the effective solar gravitation is less than that computed from the comet's position in its orbit. b. The comet nucleus rotates in a sense opposite to its orbital motion, the heated area being carried a short distance into the dark region. The rebound now has a component opposite to the orbital motion, as indicated by the longer arrow; this retards the comet, which gradually spirals toward the sun, as shown by a dotted path. This is the case of Encke's comet, in which the period is shortened. c. Direct nucleus rotation produces a rebound that increases the orbital motion, and the comet spirals outward; this is the case of Comet D'Arrest.

Convention at Dallas

By Charles H. LeRoy, *Amateur Astronomers Association of Pittsburgh*

MEMBERS of the Astronomical League who attended the 1952 general convention in Dallas, July 3rd to 7th, may forget that Texas is the biggest state in the Union, but they will never forget the majestic beauty of the Southern Methodist University campus; the cool air-conditioned meeting rooms of Fondren Science Hall (outside temperatures hovered around the 100° mark); the apparent immensity of the Texas skies with more stars than we "nawtherners" have ever seen; or the marvelous junior model display filling one of the two large exhibit rooms. From the Sunday preceding the convention, when visitors began arriving, until the last lingering departure a week later, Texans were on hand to drive us to points of interest in Dallas and neighboring Ft. Worth.

Following the registration of delegates under the direction of Wesley Gilliland, an informal reception on Thursday was conducted by the hospitality committee, headed by Mrs. Herman C. Sehested. A public star party in Ownby Stadium that evening attracted several hundred guests, but was cut short by the only clouds to appear during the entire convention period.

Friday morning the convention was officially opened by E. M. Brewer, convention manager. The welcoming address on behalf of Southern Methodist University was delivered by its vice-president, Dr. Willis Tate. Friday afternoon was devoted to reports from member organizations and by league officers and section chairmen, followed by a junior session which won the admiration of convention veterans. The Junior Astronomy Club of the Ft. Worth Children's Museum is deserving of the highest commendation, both to its members and to Miss Charlie M. Noble, their director, for demonstrating conclusively the possibilities in this branch of society endeavor.

The panel of experts, which proved so interesting at Wellesley two years ago, was equally successful this year. Participants were Edwin F. Bailey, Franklin Institute, Philadelphia, who was asked to substitute for Dr. William A. Calder; Walter H. Haas, director, Association of Lunar and Planetary Observers; Oscar Monnig, veteran meteor observer; A. W. Mount, long active in the lunar and planetary field; Robert M. Fannin, University of Texas, prominent in radio astronomy; James H. Karle, astronomy instructor at Lewis and Clark College in Portland, Ore., and league secretary. The writer acted as moderator. Of the 52 questions filed with the panel, 19 regarding the moon and planets were directed to Messrs. Haas and Mount, nine on radio astronomy to Mr. Fannin, and seven on meteors to Mr. Monnig. One question inquiring about the most interesting experience of each panel member provided a break in the serious discussions and an opportunity to know the experts better. Nine questions pertaining to flying saucers, Lubbock lights, and the possibilities of interplanetary travel were grouped together for a round-table discussion which brought the panel session to a close — 45 minutes beyond the scheduled period.

Fondren Science Hall, a recent addition to the Southern Methodist University campus in Dallas, site of the 1952 Astronomical League convention. Photo by Carl P. Richards.

Seventeen papers and addresses on various phases of astronomy were delivered to the convention, only three of which were read *in absentia*. It was a distinct pleasure to have Mr. Haas, long a contributor of papers to preceding conventions, deliver in person his address on "Some Long-enduring Features of Jupiter." Also there were several papers on meteors. Mr. Karle's address, illustrated by photographs taken on his two expeditions to find "The Lost Port Orford Meteorite," served the additional purpose of permitting us to view some of the magnificent mountain scenery of Oregon.

Two lectures were delivered on Saturday afternoon. Dr. Frank C. McDonald, head of the department of physics, Southern Methodist University, speaking on "Nuclear Energy," carried us with painstaking care through the elementary stages of atom splitting to illustrations and movies of the reactions in an atomic bomb explosion. Mr. Fannin's address on "Radio Astronomy" gave us an insight into his work at Cornell University and the University of Texas.

Decorations in the Student Union Building, where the annual banquet was held, were distinctly Texan, from the wagon wheel chandeliers to the Texas flags and miniature hand-painted riding boots on the tables. Musical interludes were furnished by a veteran singer of cowboy songs, accompanying himself on a guitar. Carl P. Richards, of Salem, Ore., was toastmaster. Following the dinner, the second Astronomical League award was presented by President G. R. Wright to Mr. Haas "for his outstanding leadership and accomplishment in the field of amateur astronomy." The banquet address was delivered by Dr. W. P. Bidelman, of Yerkes and McDonald Observatories, on "Peculiar Stellar Spectra — Their Importance in the Study of Stellar Evolution." With infinite care Dr. Bidelman, through a comparison of various stellar spectra, led his audience to a better understanding of this subject than many of us had ever known.

The roster of league officers for 1952-53 includes Rolland R. LaPelle, Springfield, Mass., president, and Dr. Herman C. Sehested, Ft. Worth, Tex., vice-president. Re-elected were Mr. Karle, secretary, and Russell C. Maag, Sedalia,

The general convention of the Astronomical League at Dallas, Tex., July 3-7, 1952. Photograph by Harry Bennett.

Mo., treasurer. Grace C. Scholz, Silver Spring, Md., has one more year to serve of her three-year term as executive secretary.

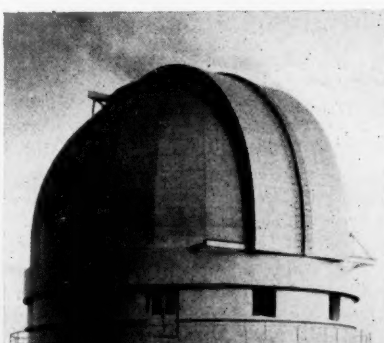
Generally, the future of the Astronomical League appears brighter than ever. Included in actions of the council was the acceptance of the newly formed Southwest region into the league. This region, comprising the states of Louisiana, Texas, and New Mexico, has elected Mr. Brewer, of Dallas, chairman, and Mr. Haas, of Las Cruces, N. M., representative to the general council. Other Southwest officers are Gerrit Van den Berg, Groves, Tex., vice-chairman; James McMillan, Ft. Worth, secretary-treasurer; and Miss Noble, chairman of junior activities. The Southwest region becomes the seventh organized region of the league.

Location of the 1953 general convention will be announced shortly, to be probably in an eastern state. An invitation was accepted from the Madison Astronomical Society in Wisconsin for the 1954 convention, to follow the total eclipse of the sun on June 30th, that year. A three-day interim will permit those witnessing the eclipse from scattered points to drive to Madison before the convention opens.

Registration at the Dallas convention was 222, and included visitors from 19 states and the District of Columbia: California, 2; Georgia, 3; Illinois, 2; Kansas, 2; Kentucky, 3; Maryland, 4; Massachusetts, 4; Michigan, 1; Mississippi, 1; Missouri, 6; New Mexico, 5; New York, 4; Oklahoma, 7; Oregon, 4; Pennsylvania, 10; South Carolina, 1; Texas, 156; Virginia, 2; Washington, D. C., 1; Wisconsin, 4.

Copies of the convention *Proceedings* can be purchased by sending one dollar ($1.00) to Mr. James H. Karle, 10925 S. W. 49th Ave., Portland 19, Ore., who will mail them as soon as they are available.

At the conclusion of the convention, 31 persons took the bus tour to McDonald Observatory in western Texas, and still others made the trip by plane and by car. The group was shown around the observatory by Dr. Bidelman, but for evening observing it was far from clear. As a matter of fact, the thunderstorm Monday evening was most awesome; lightning flashed around the entire horizon, and rain later fell in torrents. A few holes in the clouds allowed settings on Mars and Saturn, with the 82-inch telescope being used visually. The big telescope and the new coude spectrograph that is being installed were of great interest to all.



McDonald Observatory, where delegates had a chance to look through the 82-inch telescope, whose dome is shown here. Photo by Carl P. Richards.

COMET THEORIES

(Continued from page 271)

is appropriate to remark, as I have done previously, that we seem to have strong evidence of the existence of two entirely different kinds of meteors: those that form large irregular chunks like the Sikhotay-Alinsky meteorite which Fessenkov has described as a small minor planet, and those that belonged originally to comets and were then dispersed after passing through the stage of being shower meteors.

The former, because of their irregular form, their chemical and crystalline properties, are probably the debris of collisions in the ring of minor planets. The cometary meteors, on the other hand, cannot be explained as the product of a cosmic "gravel mill." Whipple, together with G. P. Kuiper, and most recently with H. C. Urey, leans toward the hypothesis that attributes the origin of comets to the condensation of the primordial solar nebula in its outermost regions, beyond the orbit of Pluto. This hypothesis differs from Oort's earlier tentative suggestion (*Sky and Telescope*, February, 1950, page 82) that the comets might have been produced at the time of the breakup or explosion of a large planet in the belt of the asteroids. The principal reason for preferring the new hypothesis is that it accords better with the chemical constitution of comets.

NEWS NOTES

By Dorrit Hoffleit

HIGH-VELOCITY STARS

In speculations on the origin of stars of Population II, the question arises whether the high-velocity stars originated within the central bulge of the galaxy or farther out. In the *Astronomical Journal,* May, 1952, Dr. Martin Schwarzschild, Princeton University Observatory, examines the question on the basis of data tabulated by Miczaika in 1940 for 555 high-velocity stars near the sun. The orbits of high-velocity stars appear to remain virtually unchanged by perturbations during the lifetime of the galaxy. Hence, we may assume that the place of origin of such a star lies on or very near some part of the star's present orbit in the galaxy.

Dr. Schwarzschild finds that 85 per cent of the orbits lie between perigalactic (nearest the galactic center) distances of 2,400 parsecs and apogalactic distances of 16,000 parsecs. The sun's distance from the center is about 8,000 parsecs. If, by analogy with the Andromeda nebula, the central bulge of our system has a radius of not more than 1,500 parsecs, the great majority of the orbits of the high-velocity stars do not penetrate the central bulge; at most, five per cent of the 555 stars do penetrate the bulge. It therefore appears that the high-velocity stars have most probably originated outside the nucleus of the Milky Way system.

MICROMETEORITES AND ROCKETS

The existence of micrometeorites (which have diameters of less than 1/100 centimeter) in the earth's atmosphere has been revealed in the past few years by several lines of investigation. These include the nature of the zodiacal light, the excessive nickel content of deep-sea deposits, and the presence of nonterrestrial material in atmospheric dust collected by high-flying aircraft. Thus, it would be expected that V-2 rockets would encounter micrometeorites in flying at high speeds through the atmosphere. In the *Bulletin* of the American Meteorological Society for January, 1952, Dr. Fred L. Whipple, Harvard Observatory, discusses these problems as part of a general paper, entitled "Results of Rocket and Meteor Research," which was presented at a symposium on the upper atmosphere in Brussels last year.

That rockets have sometimes carried polished metal plates for the purpose of discovering micrometeorites has been known for some time, although we have not previously reported the experiments. T. R. Burnight, of the Naval Research Laboratory, has found such plates pitted with small craters having diameters from 10 to 100 microns, in such numbers as to indicate one impinging particle to about every million cubic centimeters in the upper atmosphere.

J. L. Bohn and F. H. Nadig, of Temple University, have devised another more conclusive method. Very sensitive recording equipment registers high-frequency sounds, up to 60 kilocycles, on the nose cone of the rocket. Above 40 kilometers altitude, about 60 sound pips were recorded during the firing of one particular rocket equipped in this manner, with an average of one every 2.2 seconds and with little increase in number with altitude. These would indicate collisions with micrometeorites of minimum masses of the order of 10^{-12} grams, corresponding to particles with radii of the order of two microns. Their frequency would correspond to one particle in a volume of roughly 10^8 centimeters.

AURORAE OVER BRITAIN

We note with some surprise a report in the *Journal* of the British Astronomical Association, by James Paton, director of the aurora section of that society, that "The only aurora frequency map at present in existence [for the British Isles] was prepared as long ago as 1872 by Fritz. It shows the number of nights per year on which aurora is *observed* in each latitude...."

For the period of one sunspot cycle, say 1952-1964, Mr. Paton proposes to conduct a survey in which volunteers will observe the sky for a few minutes each night, as consistently as possible. Mr. Paton stresses the importance of negative results — a record that no aurora was seen at a given time can be fully as important to plotting a frequency map as a positive observation. Aircraft and shipboard observers will also take part in the program.

IN THE CURRENT JOURNALS

EVOLUTION OF STARS, by Bengt Stroemgren, **Astronomical Journal**, June, 1952. This is an important technical review of investigations of stellar evolution, including stellar models; evolutionary changes in chemical composition, mass, rotational moment, and type of model; and the formation of stars.

TWO POPULATIONS OF STARS, by George O. Abell, **Griffith Observer**, July, 1952. "At least the groundwork has been laid for what will probably prove to be one of the most fruitful areas of astronomical research."

THE SUN'S ATMOSPHERE, by Walter Orr Roberts, **American Scientist**, July, 1952. "His is the only star in all the realm of the heavens which man can observe in its intimate structural detail."

BROOKHAVEN COSMOTRON

At the Brookhaven National Laboratory, a newly constructed proton synchrotron has produced a beam of hydrogen nuclei with an energy of 2.25 billion electron volts, or roughly five times that of the University of Chicago 170-inch synchrocyclotron. The new apparatus, which has a 2,200-ton magnet, has earned the name *cosmotron,* because it accelerates protons to velocities as great as those of cosmic rays. Its ultimate capacity is expected to be near three billion electron volts.

As higher energies are approached, it is hoped that V-particles may be detected. These are only rarely discovered in cosmic ray photographs; they are particles with no electric charge, but may be several times heavier than other cosmic ray particles.

RELATIVISTIC ROCKET

At a recent meeting of the Washington-Baltimore section of the American Rocket Society, Dr. George Gamow, George Washington University, described a fanciful relativistic rocket traveling near the speed of light. Due to the slowing of time with velocity, with such a rocket the Andromeda galaxy, 750,000 light-years away, could be reached in three or four hours!

OLBERS PLANETARIUM

In a recent issue of the German magazine *Sternenwelt* appears a picture of a small Zeiss planetarium projector that is in operation in the new Olbers Planetarium at the Bremen School of Navigation. It is housed in a chamber six meters in diameter.

The instrument has 31 projectors arranged on a metal sphere to produce 4,300 stars; there are auxiliary projectors (set by hand) for the sun, moon, planets, Milky Way, and the celestial circles useful in the teaching of navigation. Latitude change may be made from the north pole to the equator, and the pole position can be set for any part of the 26,000-year precessional cycle. The daily motion is motor driven, at various speeds.

It is somewhat startling to learn that this small instrument is now the only planetarium in operation in Germany, the birthplace of all Zeiss planetariums.

THE PHYSICS OF COMETS

The International Astrophysical Conference will be held at the Institut d'Astrophysique at the University of Liége, September 19-21. Dr. Otto Struve, Leuschner Observatory, will preside at the meeting, on the physics of comets, at which papers will be presented by several American astronomers. The reports and discussions will be published by the Société Royale des Sciences.

Two Period-Frequency Anomalies for Classical Cepheids

BY HARLOW SHAPLEY, *Harvard College Observatory*

THE SHORTEST PERIODS of variable stars of the Cepheid family are less than 100 minutes (for example, CY Aquarii), and the longest are over four months. The periods now known for some 2,000 members of this family are unequally distributed between these extremes, with strong maxima in the frequency curves for periods near half a day (cluster type), two days (Small Magellanic Cloud), and 4.5 days (classical Cepheids).

In the study of the variable stars in the Magellanic Clouds, two striking peculiarities in the distribution of the lengths of periods of classical Cepheids have turned up that appear to be of importance in considerations of the development of both stars and galaxies.

The first is the preferential concentration of the long-period classical Cepheids to the denser central parts of the Magellanic Clouds and to the nucleus of our own galaxy (as was announced in an article in the *Proceedings* of the National Academy of Sciences, *26*, 681, 1940). The tendency is well marked in the Small Cloud, where centrally located variables have on the average twice the period lengths of those in the outer areas. This tendency is less pronounced in the Large Magellanic Cloud, but it unquestionably exists (*Proc.* Nat. Acad. Sci., *38*, 286, 1952). It had also been noted earlier (*Proc.* Nat. Acad. Sci., *28*, 200, 1942) that both in the nucleus of our galaxy and in the globular clusters, where the stellar densities are high, there are few Cepheids of the usual period length of three to seven days, but a preference for periods greater than seven days.

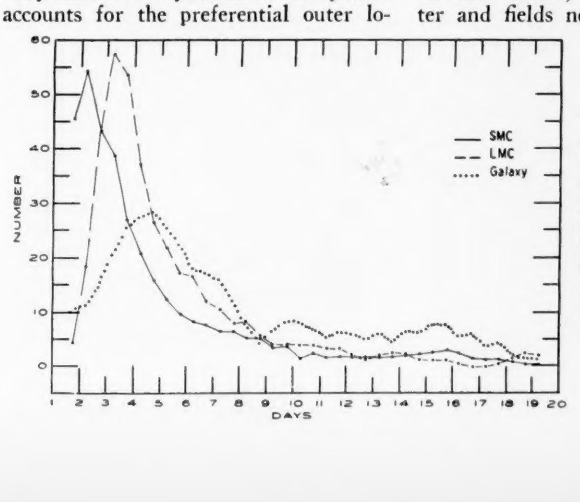
The longer-period Cepheids are, of course, brighter and presumably more massive than the average, and one naturally asks if the dynamics of the systems accounts for the preferential outer location of the lighter, less massive, shorter-period classical variables. Occasionally the long-period Cepheids are found far from the center, and also some short-period Cepheids (we are not here referring to cluster-type variables) are in or in line with the central regions. It is only a strong preference of massive stars for the denser regions that we have found, not an invariable rule.

The second peculiarity is equally definite and more puzzling. The frequency distribution of classical Cepheids differs markedly in the two Clouds and in both differs from the distribution of periods for Cepheids in our own galaxy (where the data are less complete). Table I presents the evidence at hand. The data for the Clouds are given only for fields in which an intensive search has been made for all variables, and all those found have been thoroughly studied, from the brightest to the faintest. In both Clouds, star fields near the center and fields near the boundaries are about equally involved in the study. A few superposed cluster-type Cepheids appear, but only one doubtful variable (in the Small Cloud) has a period less than one day.

TABLE I — NUMBERS OF CEPHEIDS OF VARIOUS PERIODS

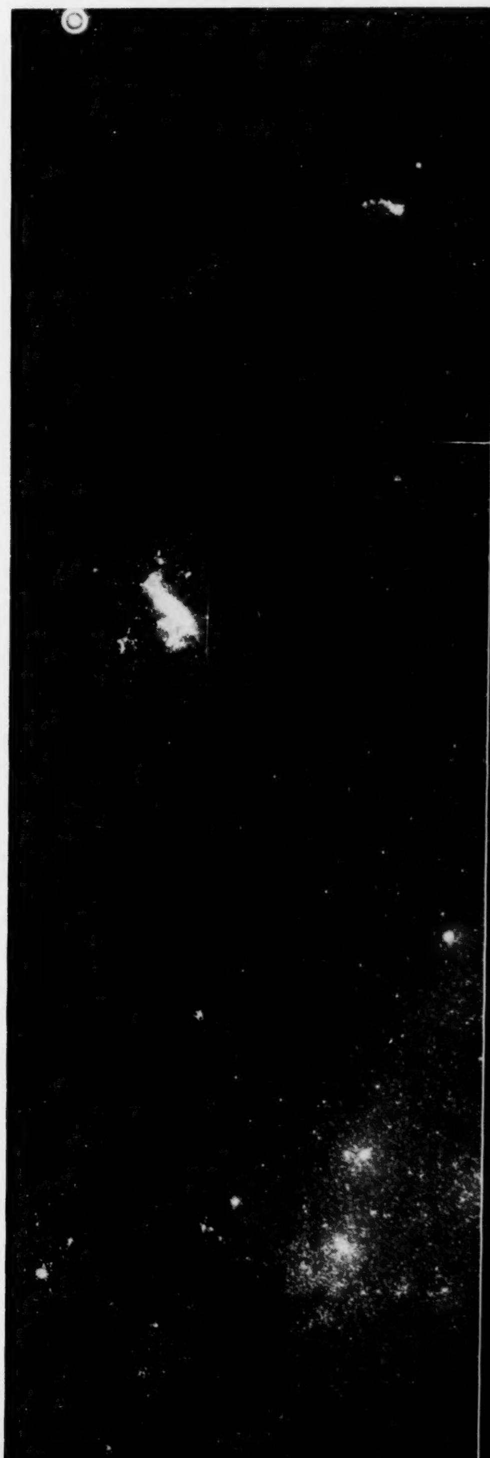
Interval of Period (days)	*Small Cloud*	*Large Cloud*	*Galactic System*
1.0 — 1.5	38	1	10
1.5 — 2.5	152	6	24
2.5 — 3.5	125	62	38
3.5 — 4.5	61	41	61
4.5 — 5.5	41	24	63
5.5 — 6.5	25	17	42
6.5 — 7.5	18	10	36
7.5 — 8.5	18	10	22
8.5 — 9.5	13	4	10
9.5 — 10.5	6	5	22
10.5 — 11.5	5	3	13
11.5 — 12.5	4	3	13
12.5 — 13.5	6	1	10
13.5 — 14.5	6	3	13
14.5 — 15.5	6	1	18
15.5 — 16.5	10	1	17
16.5 — 17.5	2	0	11
17.5 — 18.5	4	1	5
18.5 — 19.5	1	3	2
Above 19.5	28	8	58
Total	569	204	488

The much greater percentage of classical Cepheids with periods between six and 16 days in our galactic system, compared with either of the Magellanic



The frequency of periods of Cepheid variables in the two Clouds and in our galactic system are plotted here, with data reduced to equal numbers for all three systems in making this smoothed representation. Harvard Observatory diagram.

The Small Magellanic Cloud is at the upper right in this composite of Harvard photographs; the Large Cloud is at left center. The Milky Way crosses the lower part of the field. Achernar is the bright star at the extreme top left.



Clouds, is partly due to the selection of the absolutely bright variables in our inconclusive probings within our own galaxy. For example, Cepheids with periods of 10 days are nearly a magnitude brighter absolutely than those of four days at the maximum of the frequency curve. They can, therefore, be picked up at greater distances, and consequently help to distort the true frequency curve for the Cepheids in our own galaxy. Such a distortion does not prevail in the thoroughly explored fields of the Magellanic Clouds.

The smoothed curves shown in the diagram contrast the distribution of the variable star periods in the Clouds and in the galactic system. The stars excluded from this diagram, with periods greater than 20 days, account for only five per cent and four per cent of the whole material for the Small and Large Clouds, respectively.

From Table II we can get a clearer picture of the difference between the Clouds. The first three lines of the table plainly indicate the second anomaly. The interpretation is not yet clear, but we are inclined to believe that the two Clouds are hardly the twins we had previously thought them to be. Their pasts and futures may differ considerably. The Small Cloud may indeed be in a much more developed state, even if the chronological age is the same. The Large Cloud obviously is the more massive and the richer in nebulosity, dust, and supergiant stars of various kinds. The basic chemistry of the stars of the two Clouds may be effectively different,

TABLE II

	Small Cloud		*Large Cloud*	
Period	*Number*	*%*	*Number*	*%*
Less than 1.5 days	38	7	1	0.5
Less than 2.0 days	135	24	3	1.5
Less than 2.5 days	190	33	7	3
From 2.5 to 3.5 days	125	22	62	30
From 3.5 to 4.5 days	61	11	41	20
More than 4.5 days	193	34	94	46

and this difference could produce the observed peculiarities in the frequency of their Cepheids.

When other external galaxies have been equally well studied, the peculiarities may be clarified. Such clarification certainly would be to the advantage of theories of the nature and development of galaxies.

Material for our galactic system (as mentioned above) is not as definite as for the Clouds, because the survey is not nearly so exhaustive. Selection on the basis of magnitudes and sky positions has affected our collection of material. During the past two decades, however, Milky Way searches have contributed many periods (20) of less than two days. A complete census of the Cepheids within two kiloparsecs of the sun might possibly uncover a frequency like that of the Large Cloud.

Amateur Astronomers

NORTHWEST REGIONAL MEETING AT PORTLAND

PORTLAND, OREGON, was the scene of the fifth annual convention of the Astronomical League Northwest region on the weekend of June 20-22. Nearly 100 persons signed the registration book at headquarters in the Oregon *Journal* building, where the exhibit and sessions were held. The exhibit, under the direction of Norman Smale, featured a mirror grinding demonstration put on by Myron Wood.

After a brief welcoming session Friday afternoon, members traveled to the country home of Mr. and Mrs. Harold P. Haggart, of Oregon City, for a picnic supper and to view Mr. Haggart's new observatory. Although cloudy skies prevented observations, the visitors inspected the 20-inch telescope Mr. Haggart has constructed and housed as part of his residence (see page 282).

On Saturday morning Edward V. Lockhart, Jr., of Yakima, Wash., discussed "The Eclipse Saros," illustrated with diagrams and plots of various eclipse paths both past and future. An informal discussion of film and slide material available for astronomy clubs was presented by the undersigned, and colored slides of the 1951 Victoria convention and of earlier regional meetings were shown.

The afternoon session was made especially interesting by three visiting speakers. Dr. John B. Irwin, of Indiana University, gave a lantern slide talk of his "Astronomical Visit to South Africa." Charles A. Federer, Jr., editor of *Sky and Telescope,* lectured on "Evolution and Revolution in Astronomy," describing the changes in astronomy being brought about by photoelectric photometry, radio astronomy, and astronautics. "Two-color Photoelectric Photometry" was the title of a lecture delivered by Dr. C. M. Huffer, of the University of Wisconsin. He described the use of yellow and blue filters with the photoelectric cell and showed slides of some observational results. Dr. Huffer, who is secretary of the American Astronomical Society, had also been a guest at the first Northwest convention in 1948.

The banquet was held Saturday evening at the Bohemian restaurant in downtown Portland, with C. A. Wood, regional chairman, as toastmaster. Dr. T. S. Jacobsen, of the University of Washington, presented the address of the evening on the subject of "The Green Flash at Sunset." He described his own experiences in the observation of this phenomenon and discussed the various explanations advanced for the green flash. The lecture was concluded by actual color motion pictures of the spectrum of the setting sun; these revealed strikingly the presence of only green and red light in the last bit of sun to disappear below the horizon.

Officers elected at the business session were Mr. Wood, Portland, chairman; Howard Thomas, Coulee Dam, Wash., vice-chairman; Margaret Edgar, Portland, secretary; Mr. Lockhart, Yakima, treasurer; and the writer, national council representative. All were reelected except Mr. Thomas. The Northwest region now includes the Portland Amateur Telescope Makers and Observers, the Portland Astronomical Society, the Yakima Amateur Astronomers, and the Amateur Telescope Makers of Spokane.

EDWARD J. NEWMAN
324 W. Yakima Ave.
Yakima, Wash.

NOTE

For "This Month's Meetings" turn to page 281. The listing of amateur astronomical societies, "Here and There with Amateurs," which appears periodically, will be found this month on page 289.

Delegates and guests at the Northwest regional convention, June 20-22, 1952, in the Oregon "Journal" building. Photograph by Margaret Edgar.

American Astronomers Report

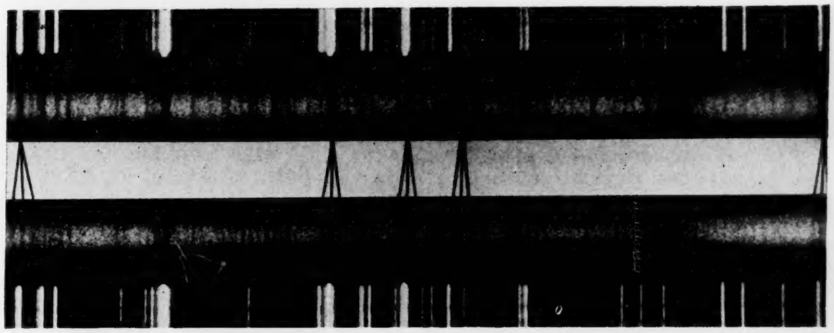
Here are highlights of some papers presented at the 87th meeting of the American Astronomical Society at Victoria, B. C., in June. Complete abstracts will appear in the Astronomical Journal.

Triple Spectrum

Although many triple stars are known, it is very rare for the spectra of all three of the components of such a system to be observable. For HD 100018, a 7th-magnitude star in Ursa Major, high-dispersion spectra made by R. M. Petrie with the 73-inch reflector at Dominion Astrophysical Observatory show two sets of lines which appear single and double periodically, while a third set remains stationary and appears between the oscillating pair when they are well separated, as illustrated here.

Dorothy M. Laidler has analyzed these spectra, and finds that they result from a system of two stars, about 10 million miles apart, that revolve around each other in about a week, and together circle a third star.

HD 100018 has, however, been known as a visual double star for more than a century, its period 84.7 years and the mean separation of its components 0.35 second of arc. At present the stars are so close together that they always are seen as one object with the 73-inch telescope; in 1968 they will reach their minimum apparent separation. Miss Laidler considers the brighter component of the visual pair to be the "double-line" binary with the period of about a week; these stars produce the oscillating spectra, while the other visual component produces the stationary spectrum. This star revolves 500 million miles from the pair in an 85-year orbit. The entire multiple star is about 350 light-years away from the sun.



In the upper of these spectrograms of HD 100018, the lines are single; in the lower they are triple, with the brighter star of the spectroscopic pair showing maximum velocity of approach. Dominion Astrophysical Observatory photos.

An Unusual Multiple Star

The star HD 193007, of photographic magnitude 8.1 and spectral type *B*0, is the brightest member of the small galactic cluster IC 4996 in Cygnus. Dr. Robert J. Trumpler, Leuschner Observatory, has analyzed 64 radial-velocity observations of this star made at Lick Observatory between 1926 and 1947, and found indications of an unusual multiple system in which the component stars are arranged somewhat like planets in the solar system.

The radial-velocity changes have a total range of 100 kilometers per second, and may be roughly described as "a variation of variable amplitude with a five months period superposed on a binary orbit of about 18 months period." Dr. Trumpler has attempted to represent the observed radial-velocity changes by three periodic variations. Two of these have ranges of 30 kilometers per second, with periods of 147 and 201 days, respectively; the third has a range of 60 kilometers per second and a period of 548 days, the 18-month period mentioned above.

The combination of the two shorter variations produces the periodic change of amplitude, and the period of amplitude change (beat period) coincides with the 548-day period of the longer variation. If these facts are interpreted as being due to orbital motion, the star producing the observed spectrum must have two or three fainter companions. The primary star appears to have a minimum mass of 22 times the sun's mass. It revolves in the 18-month period at a distance of 200 million miles or more from the center of gravity of itself and another, unseen star of unknown mass and distance from the primary.

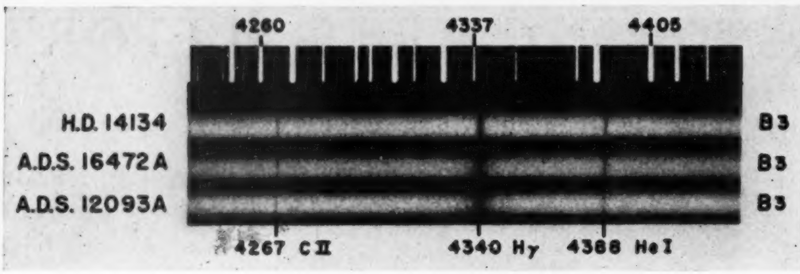
Dr. R. M. Petrie, director of the Dominion Astrophysical Observatory, host this June to the American Astronomical Society and the Astronomical Society of the Pacific in Victoria, B. C.

There appear to be at least two more stars, one revolving about the system's center of gravity in about 147 days, the other in 201 days. They have orbits of smaller size than the other two stars, but they are massive enough to disturb the primary star considerably and produce the velocity variations observed in its spectrum.

Molecular Hydrogen on Uranus and Neptune

The giant planets are noted for their strong spectral bands of the gases of molecules containing hydrogen, namely, methane (CH_4) and ammonia (NH_3), but hydrogen as a molecule (H_2) has only recently been identified in the atmospheres of Uranus and Neptune. This discovery was described by Dr. G. Herzberg, of the National Research Council of Canada. He deduced theoretically the presence of about three times as much helium as hydrogen in these same planetary atmospheres.

Several years ago, Dr. G. P. Kuiper, Yerkes Observatory, observed a diffuse line at 8270 angstroms in the infrared spectra of the two planets. In the laboratory, Dr. Herzberg has reproduced this line in an 80-meter path of hydrogen at 100 atmospheres pressure and a temperature of 78° absolute. Most of the other laboratory lines are hidden by strong methane bands in the spectra of the planets, but a second infrared line



Tracings of the hydrogen-gamma line in the spectra of the three B3 stars above give equivalent widths and absolute magnitudes of 1.4 and —5.8, 4.9 and —2.0, 7.6 and —0.4, respectively, from top to bottom. Dominion Astrophysical Observatory photographs.

(8166 angstroms) of low intensity has also been laboratory identified. The presence of helium in relative abundance is inferred from the weakness of this second line on Uranus and Neptune.

The partial pressure of hydrogen at the bottom of the visible atmosphere of Uranus is about two atmospheres; the thickness of an equivalent atmosphere of uniform density would be about 18 kilometers on that planet.

Absolute Magnitudes of B Stars

It has been known for some time that the absorption lines of hydrogen may be used to determine the true brightness of an early-type star. In the hottest *B* stars, the hydrogen lines are important spectral features, but they increase in intensity to a maximum in the somewhat cooler stars of type *A*. By calibrating the decreasing luminosity of the *B* stars against the increasing absorption of the hydrogen lines, Dr. R. M. Petrie, director of the Dominion Astrophysical Observatory, has established a system for determining the absolute magnitudes of *B* stars.

His work featured the selection and restriction of his standard stars so as to be independent of distances found from galactic motions and space reddening; the standards chosen were from certain star clusters, visual binaries, and eclipsing binaries. The total absorption of the hydrogen lines was measured by spectrophotometry.

In all, 110 standard *B* stars were used. The range in hydrogen absorption is from 1.5 to 9.5 equivalent angstroms with an associated range in star brightnesses of more than six magnitudes, or 400 times in intrinsic luminosity. The *B* stars range from 100 to about 40,000 times the brightness of the sun.

The calibration gave a smooth, fairly well-defined curve, and distances determined from it appear to be in full agreement with the system of trigonometric parallaxes. The great distances of most of the *B* stars put them beyond the reach of distance measurements by trigonometric methods.

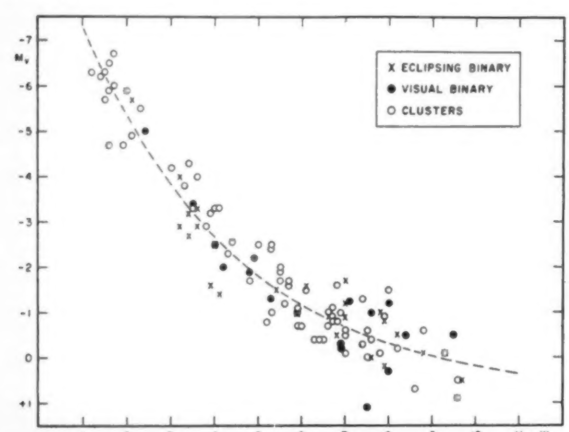
Smallest White Dwarf

A new white dwarf star, probably the smallest thus far known, was reported by Dr. W. J. Luyten, University of Minnesota, and Dr. E. F. Carpenter, University of Arizona. Called L 886-6, this 16th-magnitude star in Monoceros was found on one of the Harvard plates used in the survey for stars of high proper motion. Its position in the sky changes by the width of the moon in 22 years, indicating that it must be a nearby star.

Observations for color and a preliminary trigonometric parallax have been made with the 36-inch reflector of the Steward Observatory, University of Arizona. The parallax of 0.145 second of arc may prove to be too large, the real value falling below 0.10 second, corresponding to a distance of more than 30 light-years from the sun. Thus, were this star intrinsically as bright as the sun, it would just be visible as a 5th-magnitude star, but its actual luminosity appears to be absolute magnitude 17, about 1/60,000 that of the sun.

The star's white color requires that its surface be much hotter than the sun's, and its radiation per unit area much greater, indicating that the star is very small. Its diameter may be on the order of 2,500 miles, intermediate in size between Mercury and the moon.

Although the mass cannot be directly observed, white dwarfs may be as much as 1½ times as massive as the sun. If this were the case for L 886-6, its density would be 50 million times that of water!



The mean relation between luminosity and hydrogen absorption for the individual standard stars used by Dr. Petrie. The curve shows equivalent line widths plotted against absolute visual magnitude. Dominion Astrophysical Observatory diagram.

Refraction and the Moon

Overlooking a 60-mile expanse of Lake Michigan, the 18½-inch refracting telescope of the Dearborn Observatory, Northwestern University, has proven an ideal instrument with which to make observations of the moon to check on the value of refraction by the earth's atmosphere. In a study sponsored by the Research Studies Institute, Air University, U. S. Air Force, six times during a year the moon, when near full phase, was photographed from the moment it appeared on the eastern horizon of Lake Michigan until it reached an altitude of 30 degrees.

By measuring the distances between many pairs of sharp points on the lunar surface, Dr. K. Aa. Strand, Dearborn's director, determined the change of refraction with altitude. The pair distances at an altitude of 30 degrees were taken as standard, for the refraction there has less than one per cent of its value at the horizon. The results indicate that the increment of refraction per half degree increase in zenith distance can be obtained with a probable error of 1/100 second of arc for a series of 12 pairs of markings on a plate. Generally, this error is somewhat larger for the first two degrees of altitude.

Recently, standard tables of refraction have been criticized and various attempts made to determine the extent of their errors. Dr. Strand's method is intrinsically excellent, as he employs an extremely accurate pointing and measuring device and uses nonterrestrial yardsticks provided by the moon. In general, the values of the refraction tables long used by navigators are confirmed, but there is need for better tables of correction for the local temperature, pressure, and possibly humidity.

Further observations of this kind may serve to increase our knowledge of certain characteristics of the lower atmosphere not observable by ordinary meteorological methods.

BOOKS AND THE SKY

THE PLANETS:

Their Origin and Development

Harold C. Urey. Yale University Press, New Haven, 1952. 245 pages. $5.00.

NOBEL PRIZEWINNER Harold C. Urey in his geochemical exploration of the origin of the solar system has produced perhaps the most provocative work on the subject since the Chamberlin-Moulton planetesimal hypothesis. Urey approaches the problems of the origin of the earth, moon, and planets in a relatively new fashion, one that is becoming exceedingly important. From the present earth chemistry and from a knowledge of chemical processes at various temperatures and pressures, he attempts to deduce the physical and chemical circumstances that must have existed during the formation of the earth and planets. Any successful theory of the evolution of the solar system must meet such physical-chemical as well as the usual dynamical and hydrodynamical requirements.

Some groundwork for the chemical arguments had been laid by H. E. Suess, H. S. Brown, and W. N. Latimer, not to mention the earlier work by H. N. Russell. Urey finds two major conclusions that appear to be well established and rather critical in the processes of planetary development: 1. Almost all of the original atmosphere and hydrosphere of the earth must have been lost in a later stage of the earth's formation. 2. No one set of physical and chemical circumstances can provide the necessary geochemistry.

Urey adopts the Kant-von Weizsaecker-Kuiper type of hypothesis for the development of a planet from a discoidal nebular cloud about the sun after the sun itself condensed from a large cloud of dust and gas. As has recently become fashionable in modern evolution theories, the fact that such a discoidal ring must of necessity leave the sun rotating rapidly is completely ignored. Such a tacit omission must not be too seriously condemned for, as Kuiper points out, almost any condensation process for the formation of the sun must usually leave it rotating at a high rate of speed. Since no stars except those of very early spectral types show high rates of rotation, there must be some unknown process which reduces the rate of rotation after the star is formed. Such a possible process is the one proposed by ter Haar, who transfers the angular momentum of the sun and an assumed concomitant magnetic field into the interstellar medium via electromagnetic processes.

Urey in his proposed sequence of physical circumstances, starting with the best present-day estimates of the elements as they appear cosmically, forms a solar system in the following five steps:

1. Condensation of a proto-solar gas and dust cloud at quite low temperatures.

2. Formation of a large fraction of the earth's proto-planetary mass by accumulation of gas and dust at room temperature.

3. A high-temperature stage in which the planetary accumulation is largely completed, ending with a very high-temperature condition in which all free gaseous components are lost, including a large fraction of the silicate materials. These silicates must be lost in order to leave a sufficiently high iron concentration for the earth.

4. A second low-temperature stage in which the earth accumulates solid planetesimals and in which little volatile material is added to the planet.

5. A final stage in which the earth and moon are complete and during which the earth, which has been largely accumulated at temperatures less than 1,200° K., is now heated by radioactivity. Further energy is supplied by the gravitational separation of the iron from the silicates to form the nickel-iron core.

In this general picture none of the terrestrial planets was molten during the time of its formation. Only the earth and Venus have since become hotter because of the energy contributions from radioactive materials and from potential energy released by the fall of nickel-iron to the core of the earth.

Urey's argument depends heavily upon the still somewhat uncertain theory of the effect of high pressures on known materials within the core of the earth. He excludes W. H. Ramsey's argument that the high densities in the center of the earth result from a phase change in a basic silicate material much like the deeper layers of the mantle. The exclusion is based upon both theoretical grounds and the observed fact that Mercury, although smaller than Mars, possesses a greater mean density. On Ramsey's theory the mean observed densities of chemically similar planets should increase progressively with mass.

Much of Urey's development also depends upon his ingenious arguments that both the moon and Mars have **never** been molten, that both of these bodies represent unsegregated mixtures in which the metallic iron has not been separated, as it is assumed to be within the earth. Unfortunately, the astronomical observations on which these very important arguments rest are not as precise as one would like. The mass of Mercury still may be subject to uncertainty despite the very excellent work by W. Rabe. The dimensions and oblateness of the solid mass of Mars are still subject to certain observational uncertainties. Urey suggests that the elongation of the moon toward the earth is not a "frozen tide" but simply a residual irregularity of figure made possible by the lack of isostatic adjustment in the moon. This argument again depends upon the lack of the equatorial bulge on the moon that one would expect to form from its rotation at the time the tidal elongation toward the earth was produced. D. Brouwer's observational deduction of a circular apparent cross-section for the moon from occultation and eclipse data provides the final observational link in this argument.

Urey presents the first sequence of

processes that appears rational to the reviewer with regard to the observed fact that the earth's atmosphere contains so much free oxygen while this gas appears to be absent in the atmospheres of both Venus and Mars. Urey argues that the presence of water, presumably largely from water of crystallization in the silicates, is primarily responsible for the existence of carbon dioxide in the atmosphere of Venus and of oxygen in the atmosphere of the earth. The photodecomposition of water in the atmosphere then leads to the production of free oxygen, which in turn combines with free carbon and with methane to produce carbon dioxide. The freed hydrogen is lost by the low velocity of escape from these planets. In the presence of water the carbon of carbon dioxide can be trapped by the silicate rocks to form carbonates. Under heat the process reverses.

With an excess of water on the earth, the oxygen content of the atmosphere remains high and the carbon dioxide content low, the latter in equilibrium with various organic and other processes. On Venus, with less water and with carbon dioxide production by volcanic activity, the water has become exhausted, and the carbon dioxide constitutes most of the atmosphere. On Mars, with still less water and without volcanic activity, both the oxygen and carbon dioxide are maintained at very low values, particularly the oxygen content since both water and oxygen can escape from the planet's low gravity.

The brilliant chemical and physical arguments in **The Planets: Their Origin and Development** do not, unfortunately, lead to a very consistent story of the development of the planets and the moon. It is difficult to understand how the earth could still remain in large measure a solid during the high-temperature period, when a large percentage of the earth's silicon dioxide was being lost as a vapor while half of the planet's mass in iron was being reduced. Furthermore, arguments to produce simultaneously a moon without such reduction of iron and loss of silicates are very difficult to follow with conviction.

On the other hand, Urey's arguments for the formation of the chondritic meteors and the pallasites in asteroidal bodies much smaller than planetary dimensions are extremely convincing and seem to represent a real step forward in understanding the origin of the meteorites. This concept develops the chondrules in chondritic meteorites from fragments of reduced or partially reduced silicate masses. These broken fragments fell as a rain (or hail) in secondary condensing molten masses, chemically much like the achondrites and much as Urey visualizes the general composition of the moon.

Most astronomers will probably be quite disturbed by Urey's astroballistics. His primary argument is that some of the great lunar gashes, such as the Alpine Valley, which radiate from a point in Mare Imbrium, were produced by fragments of a huge meteorite that initiated the mare. This extension of R. Baldwin's idea is in itself not too difficult to admit, at least by those who are not still hypnotized by the volcanic arguments for most lunar craters. In the next step, however, general credence will probably be offended. Urey proposes that the large mountains surrounding Imbrium, such as the Alps, Apennines, and Caucasus, are silicate debris from this original meteorite, of dimensions perhaps a hundred miles or more. He complicates the picture further by arguing that within the meteorite was a large iron core, or cores, which then cut the furrows radially from Mare Imbrium **after** the mountains had been formed by the original silicate content of the meteorite. He even goes so far as to argue that the meteorite must have struck the moon a low-angle blow coming in from the east, splashing the materials toward westerly directions from the point of impact.

Without unduly expanding the arguments, I would willingly, or perhaps preferably, suggest that the proposed incoming planetesimal arrived from a westerly direction. This counterargument would be based upon three general principles:

a. In the forward direction of motion the resultant explosive activity would be greater. This would mean that the original mass of the planetesimal and the lunar materials became molten and therefore spread out to the east as a lava flow into the general areas of Procellarum and over the eastern hemisphere of the moon.

b. The actual mountains were probably not of planetesimal origin, but arose by shock waves toward the western direction from which the body arrived.

c. The iron projectiles to form the grooves radially from Mare Imbrium were emitted over an angular area of more than 90°. Therefore, they must have been the

NEW BOOKS RECEIVED

PICTORIAL ASTRONOMY, *Alter and Cleminshaw*, 1952, *Crowell*. 296 pages. $4.50.

Thoroughly illustrated, this book is designed for the layman. The text, which covers the entire field of astronomy, was for the most part rewritten from articles in *The Griffith Observer*, and first appeared in 1948. A number of tables give information ranging from elements unknown on the sun to distances of the nearest galaxies.

AN INTRODUCTION TO ASTRONOMY, *Robert H. Baker*, 4th edition, 1952, *Van Nostrand*. 306 pages. $4.00.

The new edition of this book is considerably rewritten from the 1947 edition, and includes a chapter on telescopes. Based on the author's larger *Astronomy*, the volume can serve as an introductory elementary text.

ASTRONOMISCHER JAHRESBERICHT, Vol. 49, 1952, Astronomische Rechen-Institut, Seminarienhaus, Augustinerstrasse 15, Heidelberg, Germany. 420 pages. DM 56.

The "Reader's Guide" to astronomical information, this volume lists by subject all of the literature for 1949. A short German review accompanies most of the article references. Vol. 48 was noted in New Books Received for March, 1951.

COMETS AND METEOR STREAMS, *J. G. Porter*, 1952, *Chapman and Hall, Ltd.*, 37 Essex Street, London W. C. 2. 123 pages. 28s.

This is Volume Two of the International Astrophysics Series, which opened with *The Aurorae*. The book emphasizes the orbits of comets and meteors, and their changes, including some original mathematical material.

result of an explosion rather than the direct momentum of the incoming planetesimal.

Almost everyone will have his own and different opinion on this matter, so I mention these points only for the sake of illustrating the type of uncertainties that may arise in the minds of those who read Urey's astroballistic discussions.

It is probable that most readers of this book will agree that further knowledge and thinking concerning the development of the earth and planets is necessary to clarify the nature of initial processes, and that the clarification is not an accomplished fact. On the other hand, Urey must be congratulated upon his courage, enterprise, and brilliancy in attacking such a complicated and interlaced array of so many extremely difficult problems covering all branches of physical science. The fact that he has been able to find any partially consistent path through this intricate maze is a credit to his intellectual prowess.

Whatever its deficiency, **The Planets: Their Origin and Development** is required reading for anyone who has serious interest in the problem of the evolution of the solar system. Most of the text is readable by those without much chemical training, but all implies a rather thorough astronomical background. The serious amateur astronomer should be able to follow the arguments sufficiently well to be amply rewarded for his time spent in reading this book.

FRED L. WHIPPLE
Harvard College Observatory

TERMINOLOGY TALKS

J. HUGH PRUETT

First Day of Century?

We sometimes see the statement that January 1, 1801, the date of the discovery of Ceres, was the first day of the 19th century. Others have contended that the century opened one year earlier. There were heated arguments around 1900 as to when the 20th century began, and again in 1950 when some writers stated that on January 1st of that year the century was already half gone. Others pointed out that we had to wait for the year to transpire. Who was right?

From the *Sidereal Messenger* (predecessor of *Popular Astronomy*) of 1889, we quote the line of reasoning of astronomer Lewis Swift, of Rochester, N. Y.:

"There was no year 0. The year previous to A.D. 1 was 1 B.C. January 1, A.D. 1, was the first day of the first century, and therefore January 1, 1801, was the first day of the 19th century."

The editor, W. W. Payne, waxed almost sarcastic: "The 20th century begins at midnight, December 31, 1900. This is so simple and plain it is cause for wonder that anyone could be in doubt on the subject. The year is always the current, not the complete year. There was no year zero. The Christian era started with the year 1, and when 1900 has passed, we shall reach the 20th century."

Surely no one has ever read that an important battle or other historical event occurred in 0 B.C. or A.D. 0 — or just plain 0.

Arguments of this kind are of interest to the common man, concerning him as personally as those that touched our ancestors during the adoption of the Gregorian calendar in the British Empire 200 years ago.

THIS MONTH'S MEETINGS

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. Sept. 22, sixth anniversary.

Indianapolis, Ind.: Indiana Astronomical Society, 8 p.m., Butler University. Sept. 7, William Garnatz, "Star Colors."

Miami Springs, Fla.: Gulfstream Astronomical Association, 8 p.m., intra-mural armory, main campus, University of Miami. Sept. 26, Harry Robertson, University of Miami, "The Source of the Sun's Energy."

Pittsburgh, Pa.: Amateur Astronomers Association, 8:15 p.m., Buhl Planetarium. Sept. 12, C. H. LeRoy, "The Convention in Texas."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Dept. of Commerce auditorium. Sept. 6, Arthur A. Hoag, U. S. Naval Observatory, speaker.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

The Haggart Observatory at Oregon City

In 1920, while reading Flammarion and Gore's **Popular Astronomy,** an irresistible urge to own a fair-sized telescope came over me. Textbooks on optics and light physics furnished the basic principles which, together with a local optician's spectacle grinding machine, resulted in a 6-inch and then an 8-inch mirror of plate glass, both completely innocent of Foucault aid and parabolic finesse. During the following years, the drawing of numerous plans proved to me that I couldn't have everything one might desire in a mounting. Also, the growing use of electronic devices in connection with astronomical machinery complicated the designs.

With considerable juggling, I emerged seven years ago with final plans for a telescope containing five points of focus. By modifying Porter's Springfield mounting to carry the 90-pound, 20¼-inch pyrex mirror (4" thick), and taking advantage of Cassegrainian compression of tube length, I could just arrange the whole thing inside a 17-foot dome (see the front cover).

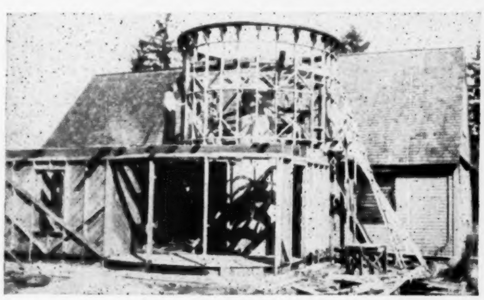
When the mirror is made first, a procedure favored by most amateurs, it is comparatively easy to adapt a tube and mounting to fit the mirror. Those who like problems in optics find the reverse order enjoyable; thus I followed this latter sequence.

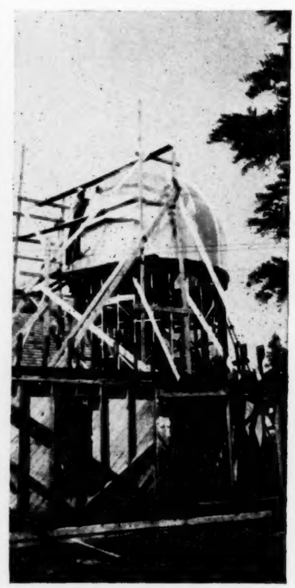
Pier. Being something of a Scotchman, I erected the dome over a needed extension of my residence to save roof expense. To raise the telescope to see over a 22' gable of the house, I built a pillar of concrete and field stones 18' above ground line. Its base is 10' below ground level, and 10' in diameter. Every 4' to 6' the rising column diminishes 2' until at the top it becomes a rectangle 24" by 30". Neither the observatory floor nor the residence structure touches the pillar at any point above the ground. There are about 35 tons of concrete and stone in the column and footings for the observatory.

Dome. The base circle is the first thing to make in building a dome. Curved sections were scribed on 2" x 12" plank, using a radius wire, and were then cut with a band saw. The pieces were laminated two deep and spiked together with waterproof glue, but left disconnected at three points about the circle to facilitate their transportation from my barn loft to their permanent location on top of the observatory wall. Next, eight 5" dome rollers were bolted onto the base circle. A second circle, needed to support the dome, was made 17' in diameter, 2" greater than that of the base circle.

Dome segments were cut orange-peel shape from 0.032" aluminum sheets, hauled up over a movable frame of correct curvature made of laminated wood. The dome was assembled from a single plank scaffolding. Each segment was hand tooled into a flange, clamped to the finished section, and connected with a standing double-turn seam on the outside; the dome was rotated for each segment. My dome requires no reinforcing ribs, and is rigid enough to support the weight of four average-sized men. It rises to a height of about 26', and is equipped with double shutters.

The dome-rotating machinery is housed on the observatory floor, north of the telescope, in a cabinet that has a sloping top for star charts. A 1/3-h.p. reversible 1,750-r.p.m. motor furnishes power



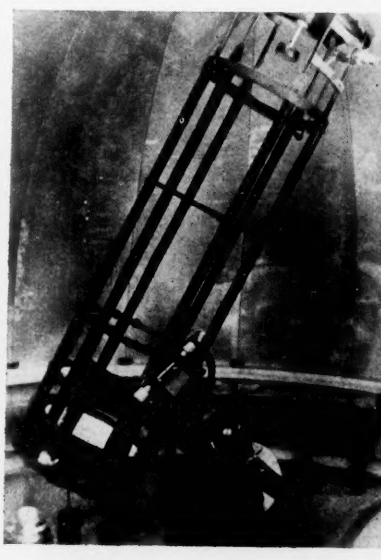


Three photos by the author record the construction of the observatory. First the 35 tons of pier and footings were built, followed by the extension to the house, and finally the assembly of the ribless aluminum dome. The pier rises 18 feet above ground level.

Harold Haggart stands at the Springfield focus of the 20-inch, with his hand on the dome control. There are individual collimating rings for each eyepiece on the triple eyepiece system. The troweled concrete counterweight is to the left. Photos on this page by Bob Barnes.

through a used washing-machine worm gear and belt drive to the main cable drum. A 5/16″ ship's tiller cable of high tensile-strength plow steel rotates one turn about the drum, thence out through the observatory wall, over the necessary idler sheaves where it encircles the dome. The cable tension is maintained by a spring-loaded idler pulley. I spliced three successively larger cables in finding out that ordinary steel sash cable was not strong enough to be used for this purpose.

Mounting. The telescope polar axis is 4″ steel shafting, carried on two Timken tapered roller bearings of 7⅛″ outside diameter, the kind used in heavy logging trucks. The bearing housings were successfully line welded into alignment, instead of by the customary line boring method. The main drive gear floats on the polar axis and is clamped by a threaded collar fitted with spokes like a ship's tiller wheel. This gear is about 19″ in diameter, with 360 teeth of 20 diametral pitch. The right-ascension circle, cut from 3/16″ aluminum plate, rotates on a shoulder



The Newtonian focus can be switched to any of six positions around the skeleton tube. Note the Cassegrainian secondary in place.

turned upon the gear hub, and is clamped to the gear by a threaded collar.

Bolted flat across the top of the polar axis flange is a platform of 1" steel plate, 10" wide. One end carries a 2" shaft and two concrete counterweights of 500 pounds. The weights were not cast, but built up by troweling on successive layers about 1" thick of Portland cement and sand, alternated with strips of hardware cloth. I allowed 12 hours drying time between trowelings; when the weight lifted the tube, I stopped.

Left: A view of the mirror cell, showing the flotation system with 18 balanced support points.

Right: A unit of the dome roller assembly. The main roller is five inches in diameter. Photographs by Howard D. Thomas, Coulee Dam, Wash.

The opposite end of the heavy steel platform carries two tapered roller bearings like those on the polar axis, and separated about 9". In these bearings rotates the 4" declination axis, a steel section of ship's propeller shafting, with a 1¾" bore through its length to admit the long cone of rays to the battery of eyepieces at the Springfield focus directly over the polar axis. The declination axis is locked by a split ring turned from ½" steel plate, which clamps about the periphery of the tube flange. The split ring is hinged and pulled together for either sliding tension or full lock by an acme threaded shaft. The large declination circle surrounds the split ring locking device. Made from ⅜" x 1" steel bar, the band was turned down a few thousandths at a time until the ends of a steel tape with 360 divisions, each 3/16" wide, came exactly together. Then I scribed degree segments on the periphery of the steel ring, using the tape as a guide.

Tube and Cell. The telescope tube is a hexagon built of 2" and 1½" water pipe welded to steel circles ½" thick. The balance point of the tube lies relatively close to the mirror end. The Cassegrain focus of the instrument falls 9" behind the primary mirror flotation system; a 3" hole in the primary allows observations to be made there. When a diagonal is placed in front of the mirror, a modified coude or Porter-Springfield arrangement is possible, at the focus of which three eyepieces rotate about their common center. The battery of eyepieces is mounted on a dovetail slide, with focusing controlled by a rack and pinion.

The rack and pinion at the Newtonian focus is carried on a frame which may be quickly clamped to any of the hexagonal positions about the tube framework, thus eliminating the need for rotating the upper section of the tube when observing various parts of the sky.

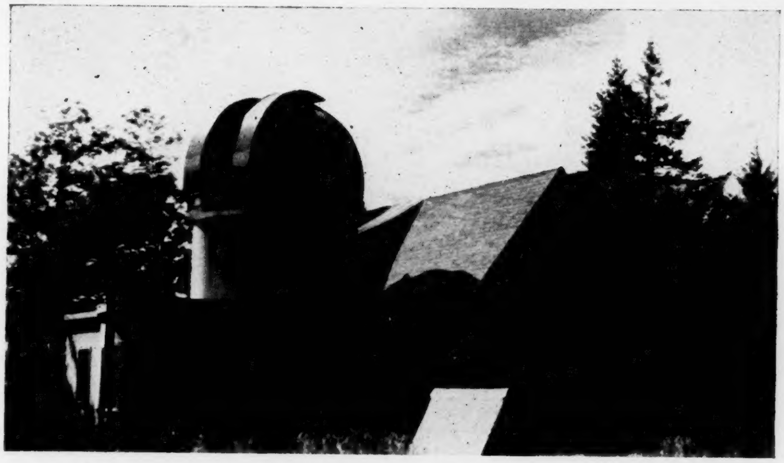
The Newtonian diagonal and the Cassegrainian secondary, which may be readily interchanged, are mounted on the end of a piston similar to the chuck on a lathe headstock. This piston is of ¾" brass tubing, ⅛" wall, and is 17" long, threaded at both ends. It is gripped with any desired degree of friction by two thick rubber washers inside of and at each end of the collimation cylinder centered in the spider, variable tension being secured by three screws.

When the collimating cylinder is withdrawn from the spider, a photographic plateholder may be mounted at the prime focus of the 20-inch mirror.

Incidentally, for those planning Cassegrainians, remember that slight movements of the secondary result in large changes in the location of the final focal plane. With my f/5, the ratio of these movements is about 1 to 32.

An 18-point Hindle-type flotation system, consisting of six triangles mounted on ball joints carried in pairs on rocker arms, supports the mirror (see **Amateur Telescope Making**, p. 231). The three rocker arms are mounted on threaded cylinders adjustable parallel with the tube axis. Twelve ½" thrust bolts with leather-padded faces, positioned radially about the mirror, and three safety fingers on dovetail slides overhanging the mirror face by ¾", complete the primary mirror cell. This leaves the glass exposed all around.

Clock Drive. The clock-drive mechanism, bolted to the observatory floor separate from the telescope pier, is motivated by an 1,800-r.p.m., 1/20-h.p. synchronous motor operating a 60-tooth worm wheel which is keyed to a floating collar about the drive spindle. This collar and a double set of speed-reduction spur gears constitute a differential cage, transmitting a constant rotation of 7.5 r.p.m. to the spindle. Change of speed of this spindle, for slow motion in right ascension, is accomplished by a 1,100 r.p.m. reversible motor, operated by a remote-control spring contact switch on a flexible cable from any of the five observing positions of the telescope. Worm gearing provides further reduction to the main drive gear on the polar axis. The 7.5-r.p.m. shaft is interrupted by a gear shift for a "moon drive," this being effected by alternating a 29-



This photograph, by the author, and the one on the front cover show the extension completed as an integral part of the house, with the dome high enough for good observing in all directions.

tooth and 30-tooth spur gear with a 30-tooth spur gear.

Making the Mirrors. For the grinding, polishing, and figuring of the f/5 mirror, I built a Draper-type machine, capable of handling a 36-inch mirror, in my basement. Accessory mirrors were produced on a smaller machine of the same kind. I tested the figure of several Cass secondaries by using a 15½-inch spherical mirror. This test mirror had a 3" hole through its center, and a radius of curvature about five times its diameter, thus placing it in the cone of rays from the primary mirror focus, permitting me to get by with a test mirror smaller than the primary. The test mirror, ground and finished on the large Draper, consists of two 1"-thick porthole glasses cemented together with pitch. For many weeks during the summer prior to grinding, this combination was left in the hot sun under weights to squeeze out as much pitch as possible and to bring the surfaces into close contact, in an attempt to prevent change later on. I could use pitch as my work was confined to a cool basement.

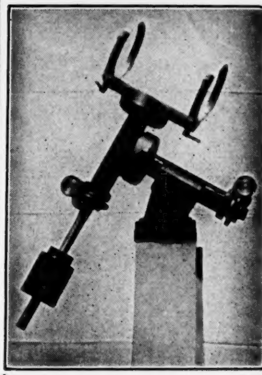
The entire dome and building construction, as well as the work on the telescope mounting, mirrors, grinding machines, and clock drive, was done by me in my spare time. The work included machining, pattern making, and electric arc welding. Castings were made by a local foundry; small stock Boston gears were used, and the only outside machining was the hobbing in of the 360 teeth for the main drive gear.

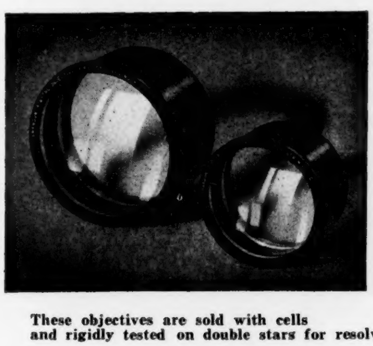
With this instrument, I can carry on the following kinds of observations: 1. Photographic work at the primary focus, with a focal length of 100". 2. Newtonian visual observations from all sides of the tube. 3. Spectroscopic observations (when a spectroscope is built) at the Cassegrainian focus behind the primary mirror. 4. Fixed-position viewing from above the polar axis. I believe this is the only successful modified Springfield mounting in a telescope this large. 5. Camera, photoelectric, or spectroscopic work at the modified coude focus looking along the declination axis; the heavens can be scanned from a fixed point.

Inside my house, access to the observatory is by an easy and artistic circular stairway built around the pier; this leads up to the second floor, where access to the observatory platform is at present by means of a ship ladder.

This observatory, to which amateurs are always welcome, is located four miles east of Oregon City at an elevation of 435 feet above sea level. I have an unobstructed view of the heavens with no interference from any neighboring lights.

HAROLD P. HAGGART
Route 2, Box 190
Oregon City, Ore.





OBSERVER'S PAGE

Universal time is used unless otherwise noted.

The Moon's Change in Apparent Diameter

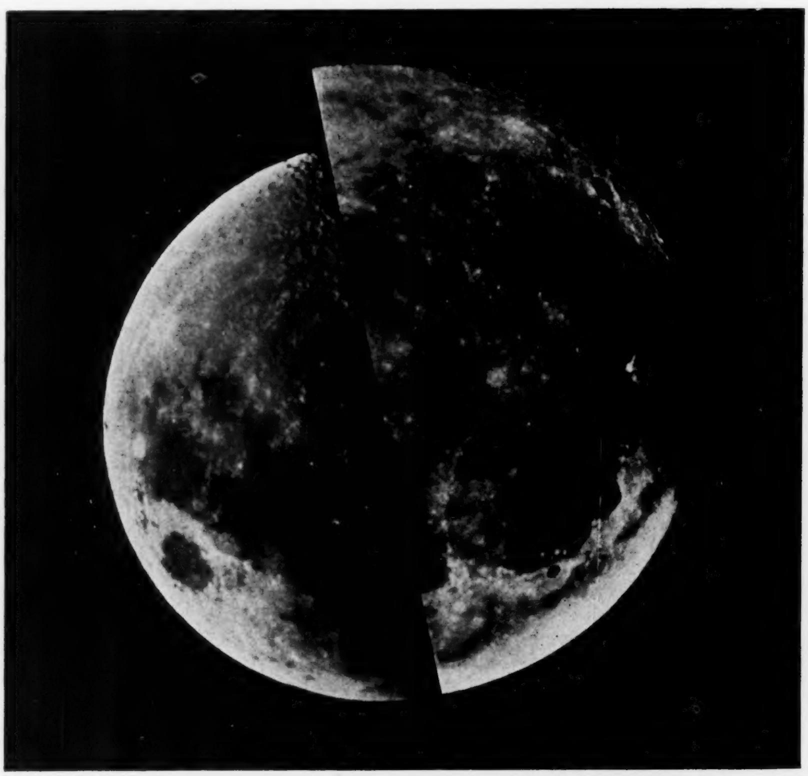
ALMOST EVERYBODY has observed that the moon appears larger when on the horizon than when overhead. So much has been written about this optical illusion that we are apt to overlook the fact that the moon's apparent size actually does change appreciably, due to periodic variations in its distance from an observer on the earth.

One real change occurs which should make the moon appear smaller on the horizon than at its highest point overhead, contrary to the usual optical illusion. In describing this effect in his article entitled "Moon Illusion," **Sky and Telescope,** April, 1952, Dr. I. M. Levitt points out that the moon is about 4,000 miles (half the diameter of the earth) closer to the observer when high on the meridian than when just rising. Since the apparent diameter of an object is inversely proportional to its distance, the moon should appear to be about two per cent smaller when on the horizon.

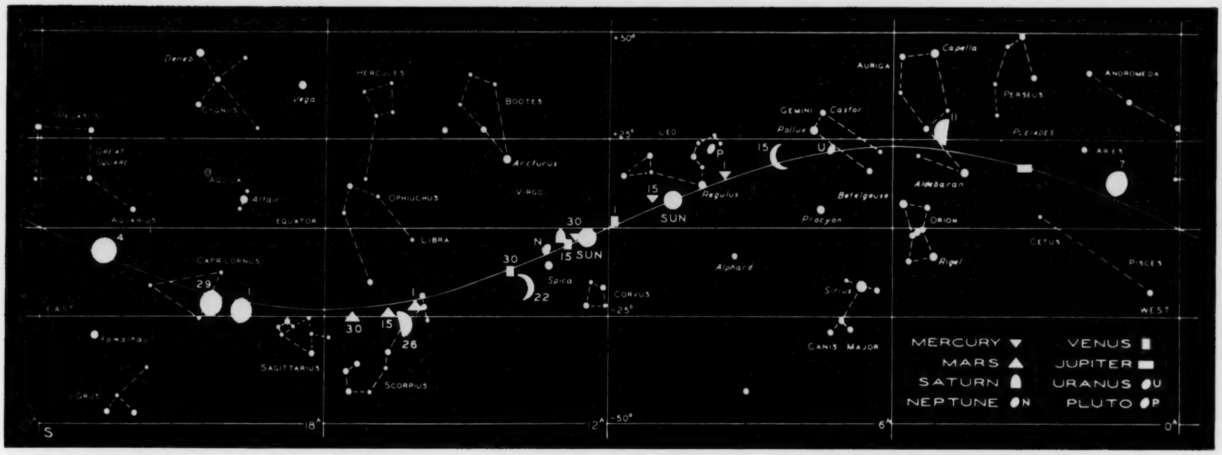
But a far greater change in the moon's angular diameter occurs each sidereal period as a consequence of the eccentricity of its orbit. We know that the orbit of the moon, with respect to the earth, is an ellipse, with the earth at one of its foci. The point on the orbit of the moon nearest the earth is called perigee, and the most remote point is called apogee. Because of this eccentricity, the moon may range from as near as 221,463 to as far as 252,710 miles. The change is so great that the light of the full moon may increase as much as 30 per cent from apogee to perigee.

Reasoning that such a large change in apparent diameter should be well within the limit of the average amateur astronomer's ability to measure, I set out to photograph the moon through my telescope at apogee and again at perigee, and to compare the sizes of the images. The accompanying photomontage, in which the smaller half is the moon at apogee and the larger half is the moon at perigee, is the startling result! It shows that there is a very appreciable change in the moon's apparent size, due to its eccentric orbit, but I must confess I had never noticed it before, after many years of gazing at the moon up in the sky.

The equipment for taking the pictures was simple: a 6-inch reflecting telescope of 50 inches focal length; a 2¼ x 3¼ Speed Graphic camera with 101-mm., f/4.5 lens; and a tripod. Using a technique described in **Skyshooting,** by Mayall and Mayall, I directed the telescope on the moon and focused, with a 32-mm. eyepiece in the telescope. Next, with the lens wide open, the camera was set at infinity, placed on the tripod, and adjusted so that its optical system was in line with the telescope's eyepiece, and with the lens about one inch from the eyepiece. After a last-minute checkup on the ground glass of the camera, a filmholder was inserted and an exposure of 1/10 second was



The apogee-perigee moon, by W. A. MacCalla.



made, on Dupont Arrow Pan emulsion.

Because of the plan to make an apogee-perigee montage, it was necessary to consult the **American Ephemeris** to select dates for photographing that would give the right combination of lunar phase and distance. The apogee photo was taken on December 28, 1949, when the moon's distance was 251,400 miles. This date was one day after the first-quarter phase. The perigee photo was taken on April 1, 1950. Full moon was on April 2nd, and actual perigee was on April 3rd, when the lunar distance was 222,900 miles. The image of the full moon on the original negative is about 1.6 inches in diameter.

The darkroom technique of producing the montage from the two negative images was considerably more difficult than taking the pictures through the telescope. Exposure time for printing each negative had to be determined, then the projected images from each negative had to be carefully positioned on the printing paper, and separately exposed. The amount of enlargement was identical, as the enlarger was not moved. Finally, the lunar images had to be masked, and the full dark sky background printed in.

Though there were many steps in the preparation of this photo, the result was very rewarding. I hope other amateur astronomers will be encouraged to enlarge their activities by teaming up their cameras with their telescopes. Perhaps some amateur will even come up with a photograph that will demonstrate that the moon's apparent diameter is really smaller on the horizon than when overhead!

W. A. MacCALLA
634 Rock Springs Rd.
Pittsburgh 34, Pa.

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

Pallas, 2, 8.4. Sept. 5, 0:24.3 —2-12; 15, 0:17.9 —4-38; 25, 0:10.5 —7-09. Oct. 5, 0:02.8 —9-34; 15, 23:55.9 —11-44; 25, 23:50.3 —13-32.

Julia, 89, 9.2. Sept. 15, 1:37.6 +35-54; 25, 1:31.1 +37-21. Oct. 5, 1:21.5 +38-08; 15, 1:10.3 +38-13; 25, 0:59.5 +37-36. Nov. 4, 0:50.6 +36-27.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1952.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will be a morning object most of the month, as it passed western elongation on August 30th. For the first 10 days of September the planet rises more than an hour before the sun in mid-northern latitudes. On the 6th, Mercury will be less than 1° north of Regulus, at magnitude —0.9.

Venus appears low in the west after sunset as a brilliant object of magnitude —3.3. It is slowly moving away from the sun, and will be most prominent in early 1953. In a telescope Venus appears at nearly full phase, with 93 per cent of its disk illuminated, and it is 11" in diameter on the 15th.

Earth will attain heliocentric longitude 0° on September 23rd at 2:24 UT. Autumn commences north of the equator and spring in the Southern Hemisphere.

Mars continues its rapid eastward motion, appearing low in the southwestern sky for 3½ hours after sunset. Of magnitude +0.5, Mars travels in Scorpius and Ophiuchus during September, passing about 2½° north of Antares on the 10th.

Jupiter rises 2½ hours after sunset in mid-September, considerably outshining all stars in the sky at magnitude —2.3. Retrograde motion commences on the 10th, and can be watched by comparing the positions of Jupiter and Delta Arietis nearby. The Jovian disk is 45" in equatorial diameter.

Saturn closely follows the setting sun in September, disappearing into its glare late in the month. On the 15th, Venus will pass 1° 37′ south of Saturn, outshining it by four magnitudes.

Uranus rises after midnight and is moving eastward in Gemini near the star Delta. Conjunction with the star occurs on September 12th, the planet ½° north. With the aid of opera glasses one can locate Uranus without a chart.

Neptune will be close to the sun all month, hence not observable. E. O.

MINIMA OF ALGOL

September 2, 17:20; 5, 14:08; 8, 10:57; 11, 7:45; 14, 4:34; 17, 1:23; 19, 22:11; 22, 19:00; 25, 15:48; 28, 12:37. October 1, 9:26; 4, 6:14.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope**, Vol. VII, page 260, August, 1948, for further explanation.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown. Add one hour for daylight-saving time.

SKY-GAZERS EXCHANGE

Classified advertising costs 10 cents a word, including address; minimum charge $2.50 per ad. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the first of the month preceding month of issue; otherwise, insertion will be made in next available issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for any statements made in the classified column, nor for the quality of merchandise advertised. Write Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

DEEP-SKY WONDERS

THIS COLUMN has been appearing for a number of years, but Dr. C. P. Custer, Stockton, Calif., of Foucault photography fame, has pointed out that at least five Messier objects have never been included. Yet many readers are interested in inspecting all of the Messier objects, and we shall discuss the missing ones (except M47) now.

M26, NGC 6694, 18^h $42^m.5$, −9° 27′, is an open cluster 9′ in diameter, with 20 stars. It is almost smothered in the great glowing Scutum shield. This cluster is not mentioned by either Webb or Smyth.

M29, NGC 6913, 20^h $22^m.2$, +38° 21′, is an open cluster 12′ in diameter, with 20 stars. Smyth mentions it, "A neat but small cluster of stars." He included it apparently because of a double star on its edge.

M56, NGC 6779, 19^h $14^m.6$, +30° 05′, is a globular cluster 5′ in diameter, of magnitude 9.5. It is not mentioned in Smyth, but Webb calls it "faintish." The fact that it lies between the famous Ring nebula and the equally renowned Albireo may account for the lack of attention it has received.

M71, NGC 6838, 19^h $51^m.5$, +18° 39′, is an open cluster, described as very large and rich. In the Shapley galactic catalogue it is given as 4′ in diameter, with 100 stars, but Webb maintains, "Large and dim, hazy to low powers with 3.7-inch, yielding a cloud of faint stars to higher magnifiers; interesting specimen of the process of nebular resolution." Smyth reports, "A rich compressed Milky Way cluster ... described by Messier as a nebula unaccompanied by stars and of a very feeble light ... first resolved into stars by Sir Wm. Herschel in 1783."

WALTER SCOTT HOUSTON

SUNSPOT NUMBERS

May 1, 28, 30; **2,** 19, 15; **3,** 13, 8; **4,** 30, 19; **5,** 30, 30; **6,** 38, 34; **7,** 27, 30; **8,** 14, 27; **9,** 9, 23; **10,** 0, 0; **11,** 4, 7; **12,** 2, 6; **13,** 9, 8; **14,** 7, 15; **15,** 12, 14; **16,** 13, 8; **17,** 15, 10; **18,** 24, 18; **19,** 25, 22; **20,** 28, 36; **21,** 31, 26; **22,** 33, 25; **23,** 32, 32; **24,** 26, 31; **25,** 16, 17; **26,** 17, 10; **27,** 54, 43; **28,** 50, 57; **29,** 40, 49; **30,** 27, 36; **31,** 16, 23. Means for May: 22.2 American; 22.9 Zurich.

June 1, 19, 12; **2,** 18, 19; **3,** 7, 14; **4,** 2, 7; **5,** 1, 7; **6,** 5, 6; **7,** 23, 26; **8,** 10, 21; **9,** 11, 8; **10,** 13, 17; **11,** 15, 10; **12,** 18, 18; **13,** 19, 20; **14,** 27, 22; **15,** 46, 46; **16,** 41, 36; **17,** 52, 45; **18,** 60, 45; **19,** 62, 55; **20,** 62, 50; **21,** 60, 50; **22,** 67, 55; **23,** 67, 70; **24,** 52, 58; **25,** 44, 56; **26,** 47, 56; **27,** 52, 52; **28,** 52, 66; **29,** 60, 63; **30,** 66, 76. Means for June: 36.0 American; 36.2 Zurich.

Daily values of the observed mean relative sunspot numbers for April are given above. The first are the American numbers computed by Neal J. Heines from Solar Division observations; the second are the Zurich Observatory numbers.

MOON PHASES AND DISTANCE

Full moon .... September 4, 3:19
Last quarter .... September 11, 2:36
New moon .... September 19, 7:22
First quarter ...... September 26, 20:31
Full moon .... October 3, 12:15

		Distance	Diameter
	September		
Perigee	3, 6^h	222,700 mi.	33′ 21″
Apogee	15, 19^h	252,100 mi.	29′ 27″
	October		
Perigee	1, 13^h	225,100 mi.	32′ 59″

OCCULTATION PREDICTIONS

September 27-28 **h Sagittarii** 4.7, 19:33.8 −24-59.5, 9, Im: **C** 3:13.6 −1.3 −1.1 90; **D** 3:06.8 −1.1 −0.7 75; **E** 2:54.3 −1.3 −0.1 65; **F** 2:42.9 −2.0 +0.1 72; **G** 2:34.3 −0.8 +1.0 18; **H** 2:06.5 −1.8 +1.6 37; **I** 2:24.5 ... ... 10.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	E +91°.0, +40°.0
B +73°.6, +45°.6	F +98°.0, +31°.0
C +77°.1, +38°.9	G +114°.0, +50°.9
D +79°.4, +43°.7	H +120°.0, +36°.0

I +123°.1, +49°.5

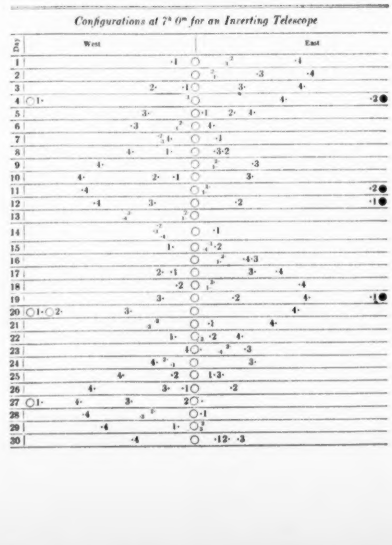
VARIABLE STAR MAXIMA

September 1, R Hydrae, 4.6, 1324**22**; 2, V Monocerotis, 7.1, 061702; 4, R Octantis, 7.9, 0556**86**; 6, S Ursae Majoris, 7.9, 123961; 6, S Pavonis, 7.3, 1946**59**; 7, V Bootis, 7.9, 142539; 12, R Carinae, 4.6, 0929**62**; 18, T Aquarii, 7.9, 2044**05**; 24, R Doradus, 5.8, 0435**62**; 25, R Aquarii, 7.3, 2338**15**; 26, R Trianguli, 6.3, 023133; 28, S Hydrae, 7.9, 084803; 29, T Centauri, 6.1, 1336**33**. October 2, T Cassiopeiae, 7.8, 001755; 5, SS Virginis, 6.9, 122001.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

JUPITER'S SATELLITES

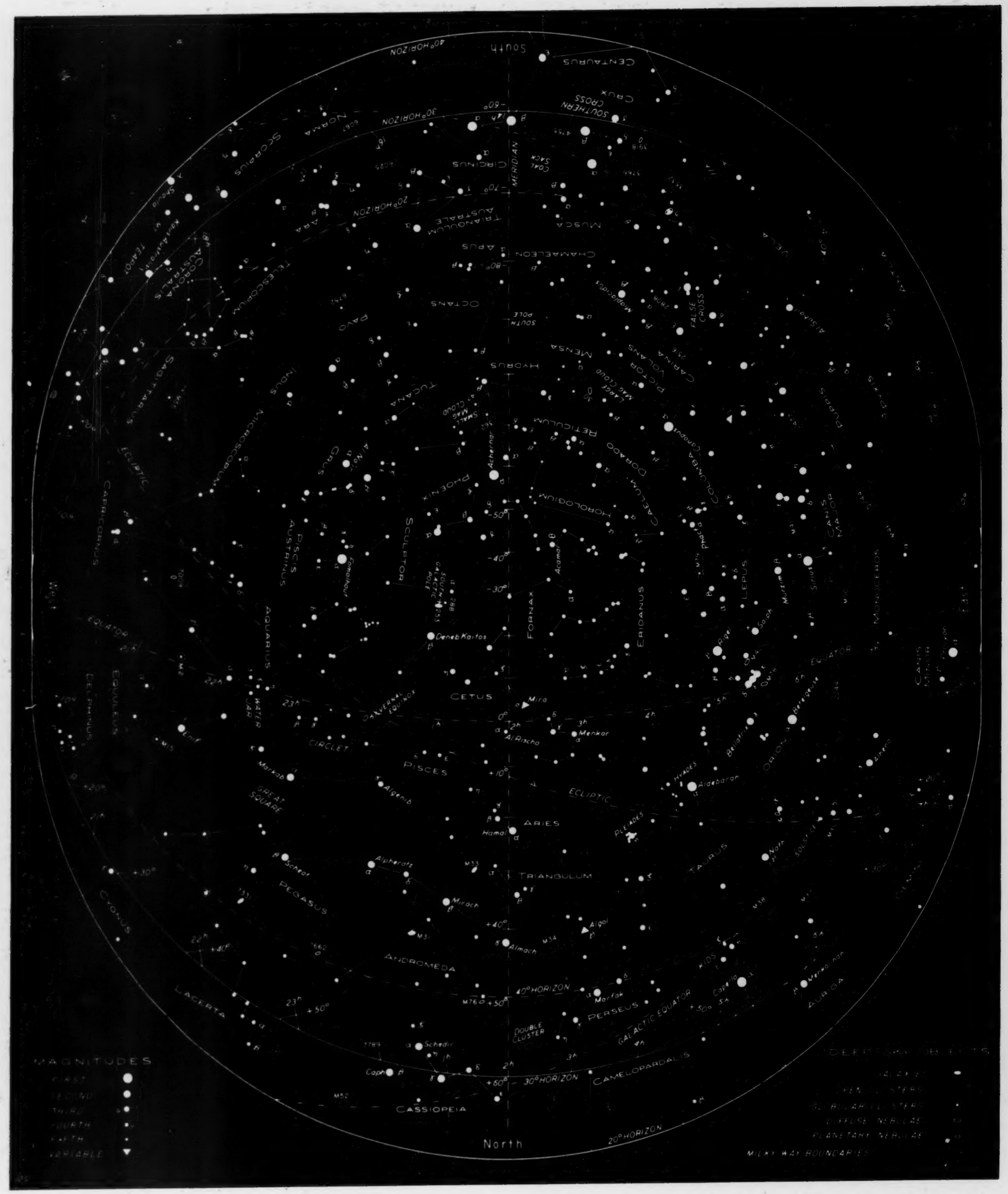
Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the **American Ephemeris and Nautical Almanac.**



Here and There with Amateurs

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ALABAMA	Gadsden	Ala. A.A.	7:30, 1st Thu.	Ala. Power Audit.	Brent L. Harrell, 1176W or 55
ARIZONA	Phoenix	*Phoenix Obs. Ass'n.	8:00, 1st, 3rd, Tue.	Phoenix College	Paul E. Griffin, 1708 S. 3rd St.
CALIFORNIA	Kentfield	*Marin Am. Ast.	8:00, 4th Fri.	Marin College	Mrs. I. Osborn, 223 Santa Margarita, San Rafael
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	H. L. Freeman, 853½ W. 57 St.
	Norwalk	*Excelsior Tel. Club	7:30, Last Fri.	Private homes	C. M. Bell, Jr., 5319 Brittain, Long Beach 8
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Miss A. Roemer, 1556 Everett, Alameda
	Palo Alto	*Peninsula A.S.	7:30, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Sacramento	*Sac. Val. A.S.	8:00, 1st Tue., bi-mon.	Sacramento College	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Fri.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	G. A. Sharpe, 4477 Muir, Bayview 3757
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton College, P-11	C. D. Corwin, 1427 N. Center St. (3)
COLORADO	Denver	†*Denver A.S.	8:00, 2nd, 4th Mon.	Chamberlin Obs.	Kenneth Steinmetz, 4282 Grove, GR 9143
CONNECTICUT	Middletown	*Centr. Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	Walter Fellows, Middle Haddam
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	320 York St.	Mrs. Helen Velardi, 437 Wash., N'th Haven
	Norwalk	Perkin-Elmer AA&TM	5:00, 1st, 3rd, Wed.	Perkin-Elmer plant	J. Vrabel, Bob White Lane, Wilton
	Stamford	Stam. Museum A.A.	8:00, 3rd Fri.	Stamford Museum	R. F. Ives, Post Rd. East, Darien
DIST. COL.	Washington	†Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Mrs. G.R. Wright, 202 PipingRk.Dr., Silv.Spr., Md.
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	†*J.A.A.C.	8:00, 1st, 3rd, Mon.	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
	Key West	†Key West A.C.	8:00, 1st Wed.	Private homes	W. M. Whitley, 1307 Div. St., 724-R
	Miami	†*South'n Cross A.S.	7:30, Every Fri.	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26 Rd.
	Miami Springs	†*Gulfstream A.A.	8:00, 4th Fri.	Armory, U. of Miami	L. G. Pardue, 641 Falcon, 88-5434
GEORGIA	Atlanta	†*Atlanta A.C.	7:30, 2nd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
ILLINOIS	Chicago	†*Burnham A.S.	4:00, 2nd Sun.	Adler Planetarium	Wm. Callum, 1435 Winona St.
	Geneva	*Fox Valley A.S.	8:00, 1st Tue.	Geneva City Hall	Joseph Zoda, 501 S. 6th St., St. Charles
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
INDIANA	Indianapolis	†*Indiana A.S.	2:15, 1st Sun.	Riley Library	Clark B. Hicks, 305 Ruckle St.
	South Bend	St. Jos. Valley Ast.	8:00, 1st Mon.	Hotel La Salle	Miss I. DeBruycker, 1023 S. Union, Mishawaka
KANSAS	Topeka	*Topeka A.A.S.	7:30, 2nd Mon.	Topeka H.S.	Miss N. Utschen, 1607 Wayne Ave.
	Wichita	†*Wichita A.S.	8:00, 1st Wed.	214 East High Sch.	S. S. Whitehead, 2322 E. Douglas, 62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 207 Sage Rd. (7)
LOUISIANA	New Orleans	A.S. of N.O.	8:00, Last Wed.	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MAINE	Portland	†A.S. of Maine	8:00, 2nd Fri.	Private homes	H. Harris, 27 Victory Ave., S. Portland
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:15, 1st Thu.	Harvard Obs.	Dr. Dorrit Hoffleit, Harvard Observatory
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	John Patterson, 142 Elgin, Newton Centre 59
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	J. E. Welch, 107 Low'r B'verly Hills, W. S'field
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Ann Arbor	†Ann Arbor A.A.A.	7:30, 2nd Mon.	U. of Mich. Obs.	Stewart W. Taylor, 1106 Birk Ave.
	Battle Creek	†B. C. Ast. Club	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett St.
	Detroit	†*Detroit A.S.	3:00, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Mrs. G. Negrevski, 2218 Amherst, 31482
	Lansing	†*Lansing A.A.	8:00, 1st, 3rd Wed.	Technical H. S.	Mrs. T. A. Louden, 940 Bensch St. (14)
	Pontiac	†*Pon.-N.W. Det. A.A.	3:00, 3rd Sun.	Cranbrook Inst.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Duluth	*Darling A.C.	8:00, 1st, 3rd Fri.	Darling Obs.	Mrs. A. Lynch, 1911 Wisconsin, Superior, Wis.
	Minneapolis	M'polis A.C.	7:30, 1st, 3rd Wed.	Public Library	Jane Simmer, 2406 Clinton Ave. S.
	St. Paul	*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	Mrs. H. Wolcott, 1705 Scheffer Ave. (5)
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, 3rd Sat.	Morrison Obs.	R. C. Maag, 816½ S. Mass., Sedalia
	Kansas City	†*A.A. & T.M.s	8:00, 4th Sat.	Private homes	Reginald Miller, Merriam, Kans.
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd or 4th Fri.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 E. Pacific, Webster Groves 19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Wed.	Univ. of Nevada	E. W. Harris, University of Nevada
NEW JERSEY	Caldwell	West Essex A.A.	8:00, 2nd Mon.	Caldwell Mun. Bldg.	D. C. Smith, 19 Francisco Ave., W. Caldwell
	Jersey City	†Revere Boys Club	7:15, Mon., Tue.	Gregory Mem. Obs.	Enos F. Jones, 339 Wayne St.
	Roselle Park	†A.A.S. of Union Co.	....., 4th Fri.	Boro Hall	Mrs. R. N. Bochau, 236 Normandy Vill., Union
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW MEXICO	Las Cruces	*A.S. of L.C.	....., 1st Sat.	Private homes	C. W. Tombaugh, 636 S. Alameda
NEW YORK	Buffalo	†*A.T.M.s & Observers	7:30, 1st Wed.	Mus. of Science	Dr. F. S. Jones, 83 Briarcliffe, Cheektowaga (25)
	Gloversville	†*A.C. of Fulton Co.	....., ...	....	L. R. Ogden, 60 W. Pine St.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	New York	†Junior A.C.	7:30, 4th Fri.	Amer. Mus. Nat. Hist.	J. Rothschild, Hayden Plan., TR 3-1300
	Rochester	†Rochester A.C.	8:00, Alt. Fri.	Rochester Museum	Peggy Lagen, 34 S. Goodman St. (7)
	Schenectady	†*S'tady A.C.	7:30, 2nd Mon.	Nott Terrace H.S.	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	7:30, Alt. Tue.	Sage Lab., R.P.I.	Dr. Robert Fleischer, R.P.I.
	Utica	†*Utica A.A.S.	7:30, 4th Tue.	Proctor Inst.	John Zimm, 239 Thieme Pl.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, Seaford Ave., 1571
N. CAROLINA	Greensboro	†*Greensboro A.C.	8:00, 1st Thu.	Woman's Coll., U.N.C.	Mrs. Z. V. Conyers, 210 W. Fisher Ave.
	Raleigh	†Astronomical Soc.	....., 1st, 3rd Thu.	N. C. State Coll.	Richard C. Davis, Sch. of Textiles
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
OHIO	Akron	*A.C. of Akron	8:00, 2nd Fri.	Beth.-Luth. Church	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	Robert Berkmeier, 2432 Ohio Ave.
	Cincinnati	*Cin. A.S.	8:00, 3rd Wed.	5556 Raceview Ave.	John Dann, 3318 Felicity Dr. (11)
	Cleveland	†Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. A. Townhill, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	7:30, 3rd Sat.	McMillin Obs.	J. A. Hynek, Ohio State Univ.
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, RR 7, Box 253A (9)
	Lorain-Elyria	*Black River A.S.	7:30, 2nd Tue.	Lorain YMCA	Louis Rick, Box 231, Lorain
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	....., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Thu.	Private homes	S. A. Hoynos, 1574 Sheridan, NE, 25034
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 905 Brentwood
OKLAHOMA	Tulsa	†*Tulsa A.S.	7:30, 1st Sat.	Private homes	Roy N. O'Mara, 1112 N. Braden
OREGON	Portland	†*Portland A.S.	8:00, 1st Mon.	Planetarium	H. J. Carruthers, 427 S. E. 61 Ave.
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Mus. of Sci. and Ind.	N. C. Smale, 831 N. Watts St.
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 4th Tue.	Com'y Bldg., Tamaqui	Mrs. R. T. LuCaric, Box 463, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 3rd Fri.	Cherry City Fire House	Cliff Raible, Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, LO 4-3600
	Philadelphia	†*Rittenhouse A.S.	8:00, 2nd Fri.	Franklin Institute	John Streeter, LO 4-3600
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	D. F. Mathe, 105 Beedle Circle (27)
RHODE ISLAND	Providence	Skyscrapers, Inc.	8:00, Mon. or Wed.	Ladd Observatory	Ladd Obs., Brown U., Jackson 1-5680
S. CAROLINA	Columbia	North'n Cross A.S.	8:15, Every Mon.	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
TENNESSEE	Chattanooga	†*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	C. T. Jones, 1102 James Bldg., 7-1936
	Nashville	*Barnard A.S.	7:30, 2nd Thu.	Vanderbilt Univ.	Miss J. Saffer, 446 Humphrey St. (10)
TEXAS	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, U6-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Fri.	Texas Christian U.	A. W. Mount, 4326 Birchman
	Port Arthur	†*Port Arthur A.C.	....., 2nd Tue.	Private homes	G. Van den Berg, Box 266, Groves
UTAH	Salt Lake City	†*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	Junius J. Hayes, 1148 East 1 S.
VERMONT	Springfield	†Springfield T.M.s	6:00, 1st Sat.	Stellafane	John W. Lovely, 27 Pearl St., 535-W
VIRGINIA	Norfolk	†*Norfolk A.S.	8:00, 2nd, 4th Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, 21745
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	Builders Exchange	Miss L. Sievers, 4018 Clinton Ave. (27)
WASHINGTON	Spokane	†*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Chet Brown, W. 1117-14th
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cha. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.
WISCONSIN	Beloit	Beloit A.S.	....., 1st, 3rd Thu.	YMCA Bldg.	Kenneth W. Schultz, 959 Johnson St.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	8:00, 2nd Mon.	Public Museum	E. A. Halbach, 2971 S. 52 St., W. Allis



The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of December, respectively.

SOUTHERN STARS

THE SIX BRIGHTEST GALAXIES may be found in December evening skies for most southern observers. Two of them, the Large and Small Magellanic Clouds, are available only for observers south of +20°. These irregular patches of light are about 80,000 light-years away, making them our nearest extragalactic neighbors. Within the Large Cloud can be seen 30 Doradus, the giant diffuse nebulosity, as well as several star clusters. Another naked-eye object is 47 Tucanae, a globular cluster near the Small Cloud, but not related to it.

Two more members of our local family of galaxies are M31 and M33, the brightest galaxies familiar to most northern observers. M31, the Andromeda nebula, at magnitude 4.5 is an easy naked-eye object; M33 in Triangulum, magnitude 6.7, usually requires a telescope with low power.

Two bright spirals in Sculptor are well placed for southern astronomers at this time. NGC 253, at magnitude 7.6, can be found near the south galactic pole, one third of the way between Alpha Sculptoris and Deneb Kaitos. A peculiar spiral only slightly fainter, NGC 55, is just on the Sculptor boundary north of Alpha Phoenicis.

STARS FOR SEPTEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of September, respectively; also, at 7 p.m. and 6 p.m. on October 7th and 23rd. For other times, add or subtract ½ hour per week. When facing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.